CADAVERIC ANALYSIS OF ROTATOR CUFF TEAR PREVALENCE IN PHYSICALLY ACTIVE AGE GROUP (20-50 YEARS)

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CHENNAI, TAMIL NADU

CERTIFICATE

This is to certify that the work "**CADAVERIC ANALYSIS OF ROTATOR CUFF TEAR PREVALENCE IN PHYSICALLY ACTIVE AGE GROUP (20-50 YEARS)"** which is being submitted for M.S. Orthopaedics, is a bonafide work of **Dr.G.SHANKARA SHANMUGA SETHU**, Post Graduate Student at the Department of Orthopaedics, Madurai Medical College, Madurai.

The Dean,

Madurai Medical College,

Madurai.

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Prof. Dr. P.V.Pugalenthi, M.S Ortho., D.Ortho,

The Professor and the Head,

Department of Orthopaedics & Traumatology,

Madurai Medical College,

Madurai.

CERTIFICATE

This is to certify that this dissertation "**CADAVERIC ANALYSIS OF ROTATOR CUFF TEAR PREVALENCE IN PHYSICALLY ACTIVE AGE GROUP (20-50 YEARS)"** is the bonafide work done by Dr.**G.SHANKARA SHANMUGA SETHU** under my direct guidance and supervision in the Department of Orthopaedic Surgery, Madurai Medical College, Madurai-20.

Prof. Dr. R.Arivasan, M.S Ortho., D. Ortho.,

The Professor and the Chief - Ortho Unit II,

Department of Orthopaedics & Traumatology,

Madurai Medical College,

Madurai.

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DECLARATION

I, **Dr. G.SHANKARA SHANMUGA SETHU**, solemnly declare that the dissertation titled "**CADAVERIC ANALYSIS OF ROTATOR CUFF TEAR PREVALENCE IN PHYSICALLY ACTIVE AGE GROUP(20-50 YEARS)",** has been prepared by me. This is submitted to **"The Tamil Nadu Dr. M.G.R. Medical University, Chennai,** in partial fulfilment of the regulations for the award of M.S. degree branch II Orthopaedics.

DR.G.SHANKARA SHANMUGA SETHU

PART A

PART –B

ANNEXURES :

a. BIBLIOGRAPHY

b. SPECIMEN PROFORMA

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d. APPROVAL FROM COLLABORATING DEPARTMENTS

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INTRODUCTION

Rotator cuff consists of group of four tendons of supraspinatus, infraspinatus, teres minor and subscapularis muscles, that join together and help in stabilizing and moving the shoulder. Significant pathology in rotator cuff can occur over a wide range of age from teenage to nineties and involves a wide range of pathology from minimal inflammation to full thickness tear. Rotator cuff tears are due to a combination of injury and weakening of the cuff tendon due to repeated micro trauma, repeated steroid injections and smoking, etc. The extent of tear depends on the quality of the rotator cuff tendon.

Weakened and degenerated rotator cuff tissue will tear easily even by normal day to day activity. In younger individuals with healthy rotator cuff, as in overhead athletes, repeated micro trauma is the cause for the rotator cuff tear. Working class people are the most commonly involved, making it economically important. It produces a significant disability in involved group of people as it affects quality of life. Rotator cuff tear affects daily activities of living such as eating and personal hygiene as it limits the abduction, internal rotation and produces significant pain in overhead activities.

When the rotator cuff tear is incomplete, it is termed as partial thickness tear and when it involves entire thickness of the tendon, it is

termed as full thickness tear. Forceful depression of an elevated arm (eccentric force) or sudden jerky lift of the shoulder (concentric force) is the most common cause of the rotator cuff injuries in younger population.

Full thickness tear may involve only one tendon such as supraspinatus alone or may involve multiple tendons producing a massive tear. Full thickness tears will not heal by itself because the muscle pull will keep the edges of the tear apart. Full thickness tears should be addressed surgically while partial thickness tears can be addressed nonsurgically in the form of physiotherapy and platelet rich plasma injection. Partial thickness tear can be surgically treated by converting them into full thickness tear, but the surgical outcome in these cases are unpredictable because of the poor quality of the tendon.

As there is an increasing incidence of trauma cases, the number of patients with soft tissue injuries is in rise. Among them shoulder joint is more commonly involved nowadays. Most of those injuries of shoulder like rotator cuff injuries are left unnoticed in the early period because of lack of knowledge and evidence of its prevalence and later on they present in an inoperable state at a younger age.

AIM OF THE STUDY

- To study about the prevalence of rotator cuff tear by cadaveric study in a small group of physically active population.

OBJECTIVES OF STUDY

- To study about the prevalence of rotator cuff tears **(supraspinatus and infraspinatus)** by cadaveric study in a small group of physically active population in order to evaluate the increasing incidence of cases of chronic shoulder pain in younger population.
- The purpose of this study was to elucidate the true prevalence of rotator cuff tears regardless of the presence or absence of symptoms in a small group of physically active population from 20-50 years of age.
- To aid in acknowledging the importance of aetiology of chronic shoulder pain in younger population.

REVIEW OF LITERATURE

In 1935, **E. LAWRENCE KEYES, M.D., of St. Louis, Mo. from the Department Of Anatomy, Washington University School Of Medicine, [2]** did a cadaveric study among an unselected series of 73 cadavers (142 shoulders) and found partial thickness tear incidence to be 13.38%(19 shoulders) shoulders which occurred only in cadavers aged over fifty years with 9 cases having unilateral and 5 cadavers having bilateral involvement. There were no associated ruptures of other tendons.

In 1964, **R E COTTON and D F RIDEOUT, Middlesex Hospital, London, [3]** did a radiological and pathological necropsy survey on rotator cuff tears. Radiographic examination of 212 shoulders (106 cadavers) found to have abnormality in 68 shoulders and those abnormal shoulders were studied pathologically. They found complete or full thickness tear in 8 shoulders and remaining 60 shoulders have incomplete tears graded as slight, moderate and severe.

In 1986, Bigliani **et al [21]** described 3 acromial shapes in scapular outlet view: type I (flat) - 17%, type II (curved) - 43%, and type III (hooked) - 40%. In this study, 58% of the cadavers had bilaterally symmetrical acromion. 33% had full-thickness tears, 73% of which were

seen in association with type III acromion, 24% with type II, and 3% with type I.

In 1988**, Ozaki J[1], Fujimoto S, Nakagawa Y, Masuhara K, Tamai**, Department of Orthopaedic Surgery, Nara Medical University,[12] did a radiographic and histological analysis in 200 cadaveric shoulder and concluded that the pathogenesis of most of the tears probably is a degenerative process as in the specimens that had a partial tear of the cuff, the under surface of the acromion was almost intact but a lesion in the anterior one-third of the undersurface of the acromion was always associated with a tear of the cuff, the reverse was not true.

In 1991**, J.JEROSCH, T. MULLER, W.H.M CASTRO, Heinrich Heine University, Dusseldorf, Germany**,[24]studied 122 autopsy specimens of the shoulder and reported the incidence of partial and complete tears as 28.7% and 30.3% respectively . More often cuff tear was bilateral and the frequency increased with age; higher incidence in females and no cuff rupture without supraspinatus involvement.

In 1993, **Hijioka A[1], Suzuki K, Nakamura T, Hojo T,** Department of Orthopaedic Surgery, University of Occupational and Environmental Health, Kitakyusyu, Japan,[26] did an anatomical study in 160 shoulders of 80 cadavers with age at death 43-93 years, (mean 69.3 years) to study the surface of the cuff and the undersurface of the

acromion by scanning electron microscopy. 98 specimens (61%) showed degenerative changes of the supraspinatus tendon and 96 specimens (60%) showed degeneration of the subacromial surface and found a significant relation between the severity of the changes in the rotator cuff and the subacromial surface.

In 1995, **Lehman C[1], Cuomo F, Kummer FJ, Zuckerman JD**, Department of Orthopaedic Surgery, Hospital for Joint Diseases, Orthopaedic Institute, New York, [9]studied the incidence of full thickness rotator cuff tears in 456 cadaveric shoulders with an average age of 64.7 years and found 17% (78shoulders- 53 female, 26 male) have full thickness tears with average age of those cadavers with tears being 77.8 years with incidence of full thickness tears increasing with increasing age. In cadavers less than 60 years of age the incidence of rotator cuff tears was 6% and in those over 60 years of age it is 30%.

In 1999, **Hirotaka Sano, MD, Hirotada Ishii, MD, Guy Trudel, MD, and Hans K. Uhthoff, MD**, Ottawa, Canada [29] determined the degree of degeneration at the insertion of 3 rotator cuff tendons in 82 cadaveric shoulders with age at death 32 to 91 years and those 6 which had full thickness tears were excluded from the study and 17 shoulders with a partial tear of the supraspinatus were studied. Intrinsic degeneration occurred foremost in the articular surface than in the bursal side and might constitute the primary cause of rotator cuff tearing. None

of the 3 tendons showed a positive correlation between their total score of degeneration and age or sex in this study.

In 2001, **A.S. Cole, S. Cordiner-Lawrie, A.J. Carr, N.A. Athanasou, Nuffield Orthopaedic Centre, Oxford, England[43]** investigated whether localised deposition of amyloid is associated with rotator cuff tear and assessed whether it is related to changes in the composition of GAGs in the tendon matrix and found Amyloid was present in 14 (70%) of the degenerative tears, but in only 2 (25%) of the acute tears which is likely to represent irreversible structural changes supporting the theory that impingement and tears are due to intrinsic degenerative changes within the rotator cuff tendons.

In 2001, **Takashi Hashimoto; Katsuya Nobuhara, and Tetsuo Hamada**, Nobuhara Hospital and the Institute of Biomechanics, Hyogo, Japan; [31]did histopathologic, histochemical, and morphometric studies on 80 torn rotator cuff tendons and found that pre-existing degenerative change in the middle and deep layers of the tendon in association with microtrauma seems to be the main cause of rotator cuff tears. A diffuse distribution of degenerative changes were observed including thinning and disorientation of collagen fibers, myxoid degeneration, hyaline degeneration, chondroid metaplasia, calcification, vascular proliferation, and fatty infiltration. All changes except vascular proliferation and fatty infiltration were more pronounced in the middle to deep layers of the

tendons than in the superficial layer suggested that these are early degenerative processes. Chondroid metaplasia and calcification may be the chronic pathologic changes that occur after tearing regardless of the type of tear.

In the year 2006, **P REILLY, I MACLEOD, R MACFARLANE,** St Mary's Hospital, London[33] had done a literature review to determine the cadaveric and radiological prevalence of rotator cuff tear and stated cadaveric rotator cuff tears were found in 4629 shoulders of which only 2553 met the inclusion criteria. The prevalence of full-thickness tears was 11.75% and partial thickness 18.49%, so total tears is 30.24%. The total tear rate in ultrasound and MRI asymptomatic was 38.9% and 26.2%, and symptomatic 41.4% and 49.4% respectively.

Lenza et al [61] evaluated 20 studies with 1147 shoulders, failed to illustrate significant difference in diagnosis of rotator cuff tear by USG & MRI.

Roy *et al*, [62] did a meta-analysis, observed sensitivity and specificity of over 90% for full thickness tear with USG and MRI. While specificity for partial thickness tear with both modalities was over 90%, lower sensitivities (67%-83%).

Over a 4-year period, **Rutten et al[63]** evaluated 5216 patients with shoulder symptoms and illustrated comparable accuracies of 95%

and 100% for USG and MRI in diagnosing full thickness tear and 89% and 67% in diagnosing partial thickness tear respectively.

In a systematic review by **Bishop *et al***, [51] increased rates and sizes of rotator cuff degeneration and symptomatic rotator cuff tears were seen in smokers which might consequently increase the number of surgical procedures in these patients.

In a study on 408 patients, **Carbone *et al***[52] found higher frequencies of smokers with at least a type II tear (34.8%) differing significantly from the type I patients (23.2%) and concluded that smoking has negative effects on vascularity of tendons.

In 2010, **Yamaguchi et al**. [64] have performed an echographic study in 558 patients with shoulder symptoms and observed that cuff tear was present in 64% of symptomatic patients with 34% - unilateral tears, and 30% - bilateral tears. Moreover, subjects with unilateral full thickness lesions have a partial or complete tear of the contralateral cuff in 20.8% and 35.5% of cases, respectively. On the contrary, in the case of partial tears, the probabilities were 29.3 % and 4.3 %, respectively. It showed that the prevalence of rotator cuff tear increases with age; in fact the group of patients with unilateral lesions had mean age of 58 years and the one with bilateral tears of 67 years.

Yamamoto *et al* [54], rotator cuff tears were observed in 65.8% patients with kyphotic-lordotic postures, 54.3% with flat-back postures

and 48.9% with sway-back postures while only 2.9% patients with ideal alignment had rotator cuff tears. The authors found poor posture is an independent predictor of symptomatic and asymptomatic rotator cuff tears.

In an Italian study, **Gumina *et al*** [55] compared the radiologically calculated subacromial space (SAS) width in 47 patients with thoracic hyperkyphosis with normal controls. They found reduced acromio-humeral space in hyperkyphotic patients, females and patients older than 60 years. The authors attributed this decrease to less posterior tilting and dyskinesis of the scapula.

APPLIED ANATOMY

Shoulder is the most mobile joint in human body. This wide range of mobility leads to the loss of stability. This instability is compensated by the rotator cuff tendons and the ligaments crossing shoulder joint. There are totally nine muscles that span the shoulder joint and get inserted into the humerus. Among those nine muscles except pectoralis major and latissimus dorsi, seven muscles arise from scapula. In those seven muscles, four muscles form the rotator cuff. Knowledge of rotator cuff origin, insertion, histology and bony morphology of shoulder is important for understanding pathology, clinical features and management protocols of the cuff tear.

Rotator cuff is a complex of four muscles that arise from the scapula and whose tendons blend in with the subjacent capsule as they attach to the tuberosities of the humerus.

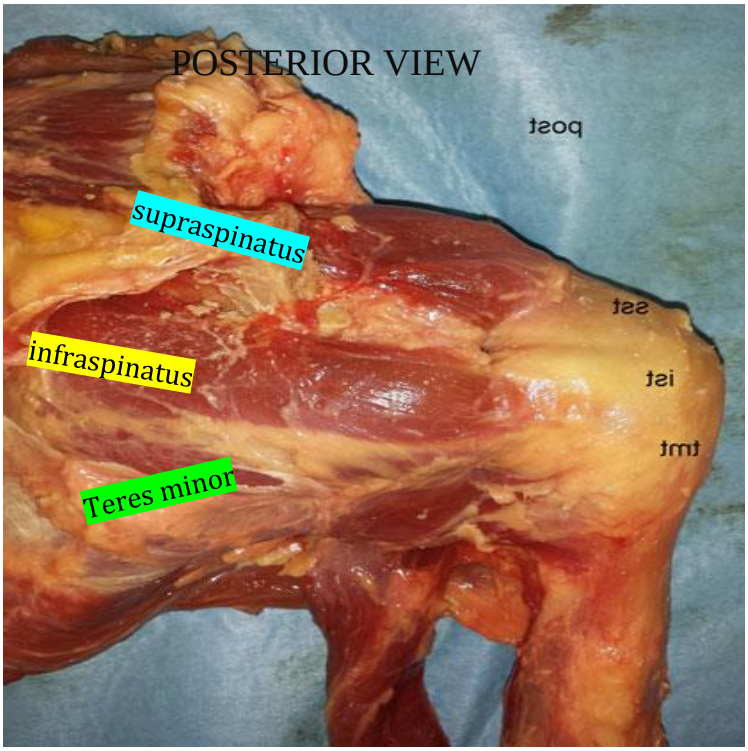
4 rotator cuff muscles are

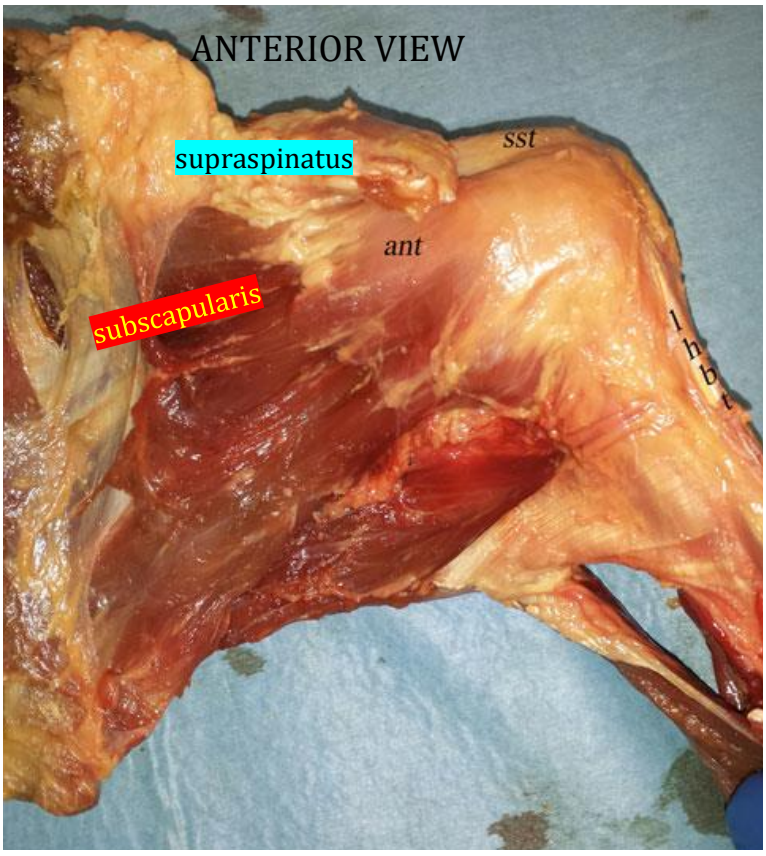
1. Supraspinatus
2. Infraspinatus
3. Teres minor
4. Subscapularis

Anatomy of Rotator cuff muscles

Muscle	Supraspinatus	Infraspinatus	Subscapularis	Teres Minor
Origin	Supraspinatus fossa	Infraspinatus fossa	Subscapular fossa	Lateral border of scapula on dorsal surface
Insertion	Greater tuberosity of humerus, Superior facet	Greater tuberosity of humerus, Middle facet	Lesser tuberosity of humerus	Greater tuberosity of humerus, Inferior facet
Action	Initiates abduction (0-15 degrees)	Lateral rotation	Medial rotation	Lateral rotation
Innervation	Suprascapular nerve (C5,C6)	Suprascapular nerve (C5,C6)	Upper and Lower subscapular nerves (C5,C6)	Axillary nerve (C5,C6)

All except the supraspinatus are the rotators of humerus; the supraspinatus besides being a part of the rotator cuff, it initiates and assists the deltoid in first 15 degrees of abduction of the arm.


POSTERIOR VIEW
supraspinatus
infraspinatus
Teres minor


ANTERIOR VIEW
supraspinatus
subscapularis

FOOTPRINT OF ROTATOR CUFF:

The insertion site of the rotator cuff tendon at the greater tuberosity is referred to as the “footprint”. The anatomic foot print of the rotator cuff has been proposed as an important landmark for recognizing the degree of partial tearing of the articular surface of the rotator cuff. The normal cuff is 9 to 12 mm in thickness but ranges from 9 to 22 mm of thickness. The foot print of the infraspinatus is trapezoidal which wraps and interdigitates with the supraspinatus tendon. The infraspinatus has a long tendinous portion in the superior half of the muscle, which curves anteriorly and extends to the anterolateral area of the highest impression of the greater tuberosity and covers the bare spot of the humeral head.

MEAN ANTEROPOSTERIOR DISTANCE	3.78 cm
MEAN MEDIAL-TO-LATERAL	1.47 cm
MEAN AREA OF INSERTION	6.2 cm^2

The articular surface-to-tendon insertion distance was less than 1 mm along the anterior 2.1 cm of the supraspinatus-infraspinatus insertion into humerus. This distance progressively increased to a mean distance of 13.9 mm at the most inferior aspect of the teres minor insertion into humerus.

	mean anteroposterior	mean medial-to-lateral
Supraspinatus	1.63 cm	12.7 mm
Infraspinatus	1.64 cm	13.4 mm
teres minor	2.07 cm	11.4 mm
Subscapularis	2.43 cm	17.9 mm

The tendinous insertions of the rotator cuff muscles, the articular capsule, the coracohumeral ligament, and the glenohumeral ligament complex blend into a confluent sheet before insertion into the humerus. The tendons of the infraspinatus and supraspinatus muscles join approximately about 15 mm proximal to their insertion and cannot be readily separated by blunt dissection. Similarly infraspinatus and teres minor fuse near their musculotendinous junctions. The supraspinatus and subscapularis tendons join as a sheath and surround the biceps tendon at the entrance of the bicipital groove.

ROTATOR INTERVAL - the triangular area in the anterior and superior shoulder where no rotator cuff tendons are present, bounded by the supraspinatus superiorly, the subscapularis inferiorly, and coracoid medially. The apex of the triangle is marked laterally by transverse humeral ligament. The coracohumeral ligament, biceps tendon, and

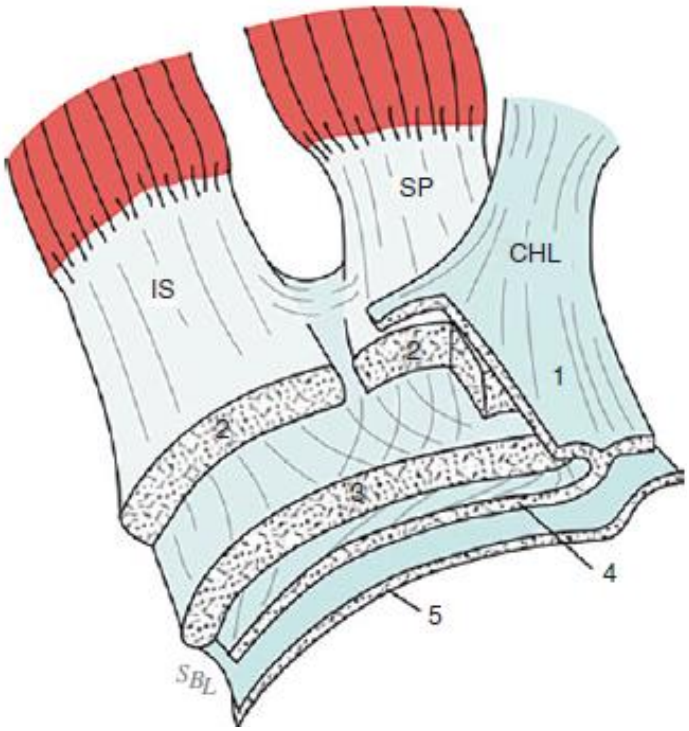
superior glenohumeral ligament are the contents. The rotator interval is altered in pathologic states.

Rotator Cuff Ultrastructure

The supraspinatus and infraspinatus have five-layers near their insertion on humerus: from superficial to deep

- Layer 1- Superficial coraco-humeral ligament layer.
- Layer 2- This layer occupies the major portion of the rotator cuff tendon. This layer consists of tightly packed tendon fibers arranged parallel in huge bundles which extends directly from the belly of the cuff muscles to insertion site.
- Layer 3-This is a thicker layer and has multiple small fibers when compared to the second layer and fibers are not arranged uniformly as in second layer.
- Layer 4- This layer contains loose connective tissue and thick collagen band which run perpendicular to primary fibers of cuff tendon. This layer has deeper extensions of the coraco-humeral ligaments and called by various names as transverse bands, pericapsular bands or rotator cable. This layer play an important role in the distribution of forces between tendinous insertion of cuff and this is why some cuff tear are clinically asymptomatic.

- Layer 5-This is the true capsular layer and forms a continuous cylinder from humerus to glenoid. The tendon fibers are oriented randomly.



The orientation of rotator cuff fibre also differs along the length of the cuff tendon. At the myotendinous junction, the tendon consist mainly of parallel homogeneous collagen fibers but when the fibers reach the humeral insertion they become flat ribbon like bundles that insert at an angle of about 45degrees [Godlike et al.]. Significantly high shear force occurs, play a major role in rotator cuff tear due to various orientation of fibers and distinct set of layers within the superior capsule complex. This intra-tendinous variation in the rotator cuff's structure explains why intra substance tear occur in rotator cuff. Shear force is directed to layer 4, and

this layer 4 is the common site for intra tendinous cuff tear. This type of tear is degenerative in nature.

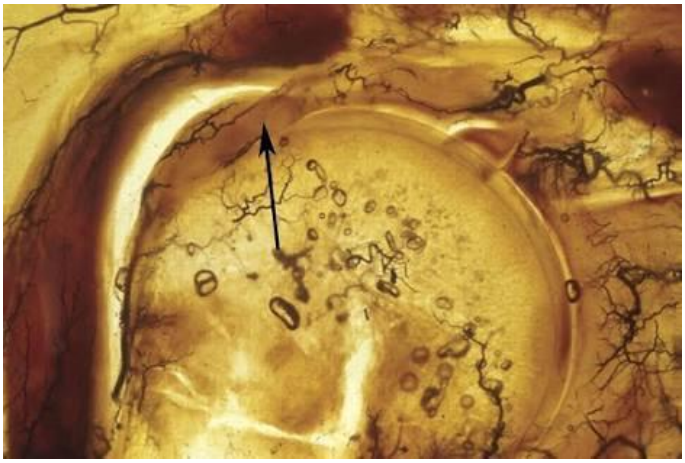
BLOOD SUPPLY TO THE ROTATOR CUFF

The major arterial supplies to the rotator cuff are

1. Ascending branches of anterior humeral circumflex artery,
2 .Acromial branches of the thoraco-acromial artery,
3. Suprascapular artery
4. Posterior humeral circumflex artery

Critical zone of hypovascularity:

Microvascular supply of the rotator cuff tendons influence the development of rotator cuff tear. Cadaver studies demonstrate a “critical zone of hypovascularity” in the rotator cuff. This is the area of highest impingement, and it lies approximately 8mm proximal to the supraspinatus tendon’s insertion. This hypovascular critical zone plays a main role in attritional degeneration of rotator cuff tendon in elderly population. In vivo analysis using polarisation spectral imaging demonstrates a good blood supply in the critical hypovascular zone in intact rotator cuff. Articular surface of the rotator cuff is hypovascular when compared to the bursal side of rotator cuff.



Arrow –critical hypovascular zone at articular surface of supraspinatus

Perfusion of the cuff is a dynamic phenomenon with markedly reduced perfusion when the arm is in full adduction. Collagen bundles located near the articular surface of the rotator cuff are thinner and less uniform than the thick parallel bundles found closer to the bursal surface. The articular surface of the cuff has an ultimate failing stress only half as high as the bursal side. This lack of uniformity of the collagen bundles along with the hypovascularity of the articular surface of the cuff are the contributing factors for the partial tear to occur more commonly on the articular surface.

Coraco acromial Arch

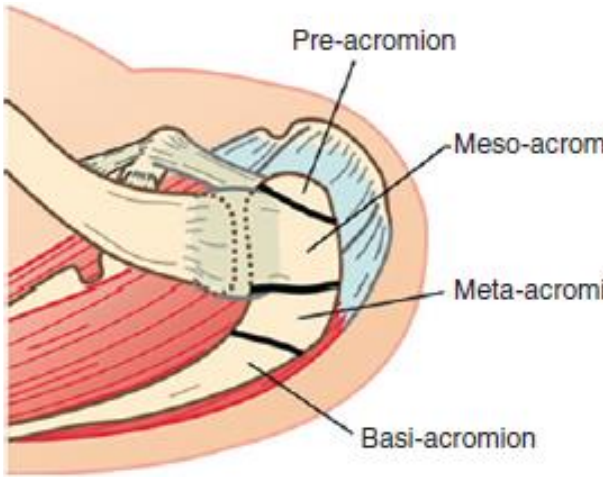
Coraco acromial arch is formed by coracoid, coracoacromial ligament and acromion. They arch over the rotator cuffs and head of the humerus.

Long Head of Biceps

The long head of the biceps tendon may be considered a functional part of the rotator cuff. It attaches to the supraglenoid tubercle of the scapula, runs between the subscapularis and the supraspinatus, exits the shoulder through the bicipital groove under the transverse humeral ligament, and attaches to its muscle in the proximal part of the arm. The coracohumeral ligament and the transverse humeral ligament keep the biceps tendon aligned in the groove. It forms the shape of a question mark while arching over the head of the humerus. It provides stability to the gleno-humeral joint during abduction and external rotation of the upper limb.

ACROMION ANATOMY

The acromion is a scapular process arising from four separate centers of ossification: a basi-acromion, a meta-acromion, a meso-acromion, and a pre-acromion. The basi-acromion typically fuses to the scapular spine by 12 years of age, and the other centers of ossification are usually united by 22 years of age but may occur as late as 25 years. When these centers fail to unite, the ununited portion is referred to as an *os acromiale*. The most common lesion is a failure of fusion of the meso-acromion to the meta-acromion.



Superior view of the shoulder demonstrating ossification centers of the acromion.

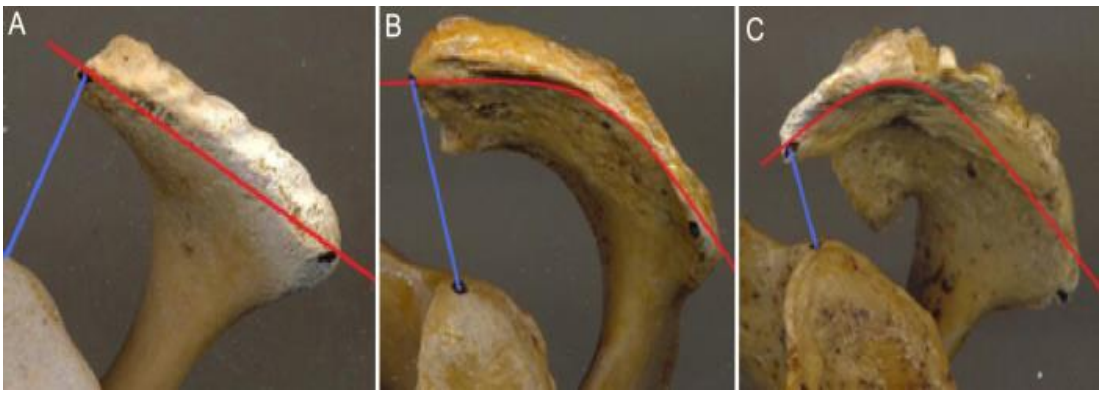
Bigliani and colleagues [21] identified three distinct acromial shapes.

Type I: A flat acromion

Type II: A curved acromion

Type III: An anterior downward hook on the acromion

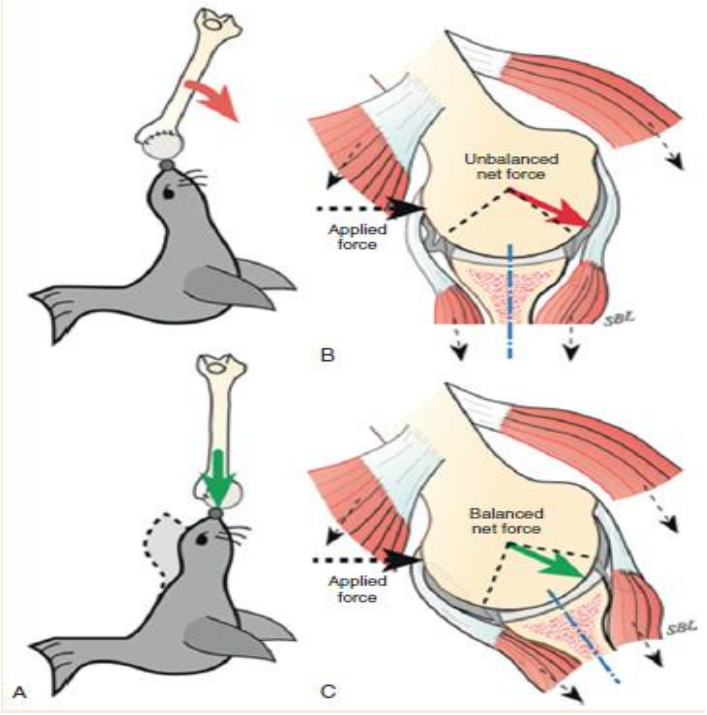
Although this classification of acromial shapes has been shown to have low interobserver reliability, the acromial slope measured on the outlet view correlates with acromial thickness.



ROTATOR CUFF'S BIOMECHANICS

The muscular constraints work in several ways to provide stability to shoulder.

First, they dynamically position the scapula to place the glenoid opposite the humeral head as the shoulder moves. Rowe compared its relationship to a "ball on a seal's nose." As the ball (humerus) moves, the seal (scapula and glenoid) moves to maintain the balanced relationship.



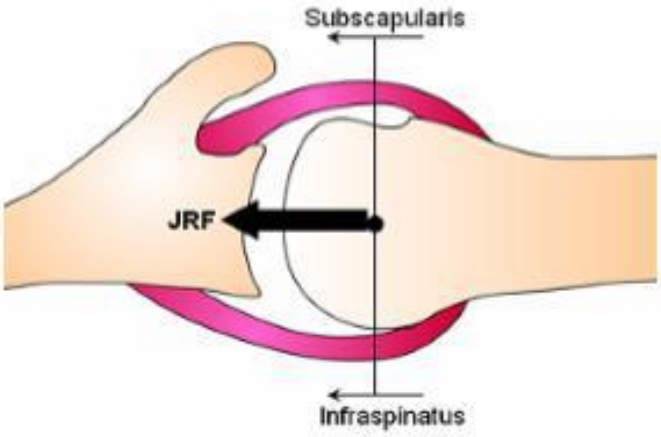
An applied force results in an unbalanced net force (*red arrow*).

Coordinated scapular movement repositions the glenoid concavity to balance the net humeral force (*green arrow*) within the glenoid concavity.

Second, whereas ligaments work in a static fashion to limit the translation and rotation, their stiffness and torsional rigidity are increased with concomitant muscle activity. Rotator cuff activity and biceps activity have been shown to stiffen the capsule and decrease the glenohumeral translation.

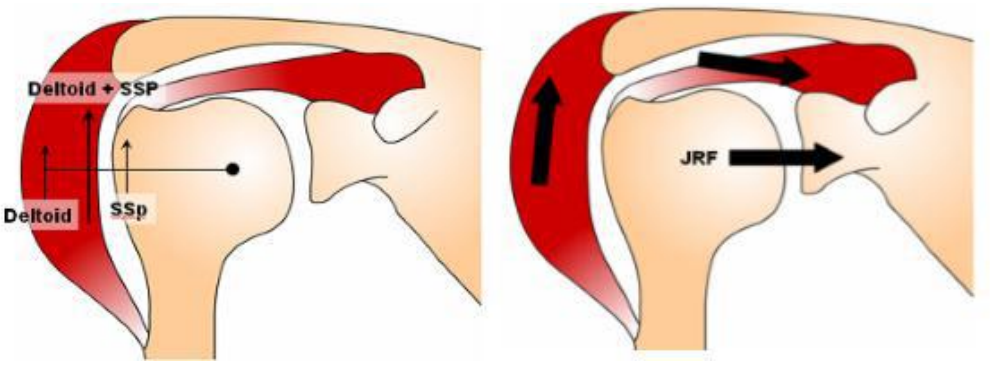
Third, intrinsic and extrinsic muscle groups serve as fine tuners of motion and power movers by working in “force couples”. The glenohumeral joint is stabilised by rotator cuff by force couples in transverse and coronal plane.

Transverse Plane Force Couple: Rotator cuff stabilizes the shoulder by compressing head of humerus against the glenoid cavity. This is called ‘concavity compression’ mechanism. This is due to the antagonistic forces of the subscapularis anteriorly, and infraspinatus and teres minor posteriorly. The joint reaction force thus produced in the transverse plane stabilizes the glenohumeral joint.This prevents the upward displacement of head of humerus in patients with cuff tear. When the force couple remains balanced, joint remains centered.



Coronal Plane Force Couple: Supraspinatus and Deltoid provides equal abduction force. Joint reaction force is directed towards the Glenoid when the arm is abducted. This reaction force is responsible for the

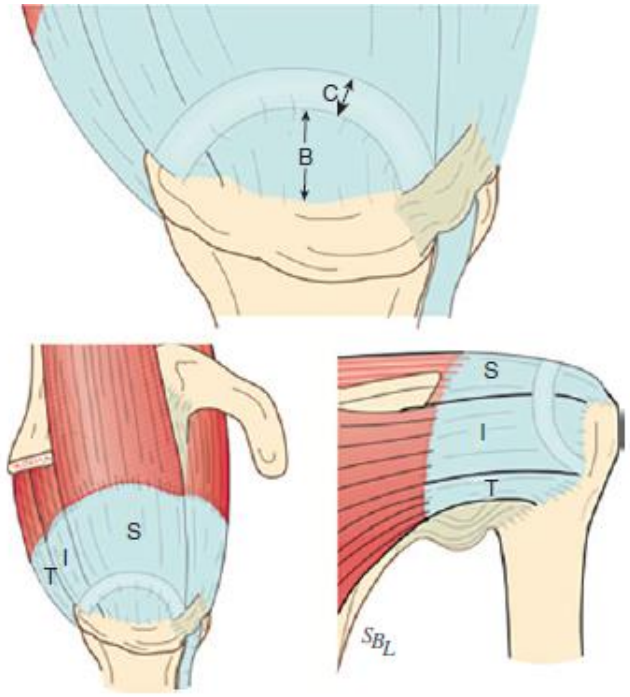
compression of head of humerus against the glenoid and thereby improving the gleno-humeral joint stability when the upper limb is in abduction and in overhead position.



Static Restraints - prevents the upward displacement of the head of humerus; are **Long Head of Biceps** and **Coraco acromial Arch**

ROTATOR CABLE & SUSPENSION BRIDGE

The concept of the “rotator cable” and “suspension bridge” should be considered when evaluating the biomechanics of a shoulder with a rotator cuff tear. A thickening of tissue seen on the articular side of the rotator cuff that runs from within the anterior supraspinatus at the biceps groove towards the posterior infraspinatus near the middle facet of the greater tuberosity in a crescent shape was originally described as a “transverse band” by Clark and Harryman [66] and termed the “rotator cable” by Burkhart et al. [65]



Superior and posterior views of the rotator cable and crescent.
B, Mediolateral diameter of rotator crescent tissue;
C, width of rotator cable;
I, infraspinatus;
S, supraspinatus;
T, teres minor

The “suspension bridge” concept proposes a protective role of the rotator cable in which the free margins of the tear correspond to the supports of the cable. A tear that occurs within the crescent tissue more lateral to the cable should be shielded from stress as long as the thicker cable tissue is intact. In these tears, the function of the superior cuff would still be intact due to distribution along the length of the cable of the suspension bridge.

The rotator cable produces a similar configuration to a suspension bridge. The free margin of the tear corresponds to the cable, and the anterior and posterior attachments of the tear correspond to the supports at the end of each cable.

FUNCTIONS OF ROTATOR CUFF

1. The cuff rotates the humerus with respect to the scapula.
2. Rotator cuff compresses the head into the glenoid fossa, which is responsible for the stability of the shoulder. This force is called '**concavity compression'** which is due to the opposing force of subscapular muscle anteriorly and infraspinatus and teres minor posteriorly. In the past it was proposed that rotator cuff is a primary depressor of the humeral head. But it is now evident that the head depression action of the rotator cuff is minimal and the primary action is stabilizing the shoulder by compressing the head into glenoid.
3. Rotator cuff provides muscle balance at the shoulder. Coordinated action of the rotator cuff muscles is very important for obtaining the desired movement of the shoulder. Balanced muscle function is needed in shoulder as the shoulder does not have a fixed axis of rotation. All the shoulder muscle work together and produce a net torque and neutralize opposite force. When pure internal rotation of latissimus dorsi is needed its adduction is neutralized by superior portion cuff and deltoid. And when pure adduction of the latissimus dorsi is required, its internal rotation is neutralised by posterior cuff and posterior deltoid muscle. When forward

elevation without rotation is required cross- body and internal rotation moment of the anterior deltoid are neutralized by the infraspinatus and posterior deltoid.

AETIOLOGY

PREDISPOSING FACTORS

Age - Advancing age has been consistently held accountable as one of the major risk factors for the development of cuff tears in various studies.

Sex- A study by Abate *et al* [44] on menopausal women revealed increased prevalence of asymptomatic FTT in the postmenopausal period. Both sexes have otherwise been quoted as being equally predisposed to the development of rotator cuff tears.

Hand dominance- While some evidence suggests greater risk of the dominant hand for developing rotator cuff tears, others find this predilection not significant.

Contralateral shoulder- In patients operated for ipsilateral partial-thickness tears or full thickness tears, opposite shoulders are at increased risks of developing the same [48].

Smoking- A strong dose- and time-dependent association has been established between smoking and the development of rotator cuff tears.

Family history- Increased risk in the relatives of individuals with rotator cuff disease has been identified. In a study by Tashjian *et al*[53], patients diagnosed before 40 years showed significant relatedness for individuals with rotator cuff disease in close and distant relationships (up to 3rd cousins) ($P = 0.001$).

PATHOGENESIS

The partial rotator cuff tear pathogenesis is multifactorial. It is classified into the following types:

Intrinsic cause:

This is due to tear of the collagen fibres due to intrinsic tendinopathy. This failure is a result of absence of uniform collagen bundle on the articular surface resulting in partial articular cuff tear. Degenerative tears occur due to aging process and this is augmented by lack of vascularity on the articular side of the rotator cuff. Histology shows loss of cellularity, loss of vascularity and loss of fibrocartilage mass at the site of the cuff insertion. 7 features of senile degeneration were thin and disoriented collagen fibres, myxoid degenerations, hyaline degenerations, vascular proliferations, fatty infiltrations, chondroid metaplasia and calcifications.

Altered collagen fiber quality also plays as an intrinsic mediator in cuff degeneration. Large amount of type I collagens and lesser amount of type III collagens are seen in central healthy region of the supraspinatus. Type II collagen which withstands compressive load is rich in the fibrocartilage region of cuff tendon. In diseased rotator cuff, type III collagen level is increased and type II collagen level is decreased within fibrocartilaginous zone. Type III collagen is associated with tendon

healing. This change in collagen composition is associated with reduced tendon ability to withstand compressive load.

Extrinsic cause:

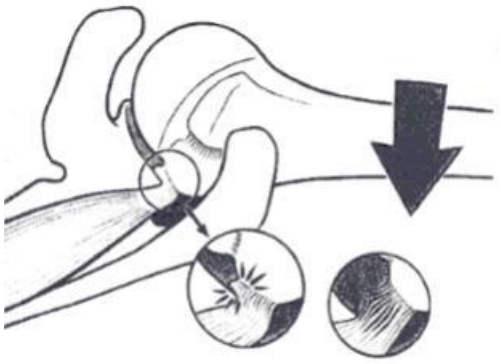
Coracoacromial arch abnormality results in narrowing of supraspinatus outlet resulting in cuff irritation and partial tear. Eccentric impingement may lead to articular as well as bursal sided tear. A differential shearing force involving the layered anatomy of the supraspinatus is another cause for articular sided tear.

Acromial morphology is an important contributor for impingement. In a study by Bigliani et al [21] of one hundred and forty shoulders, 1/3rd had complete tear of the rotator cuff, 73% was in type 3 acromion type. Lesser sloped acromion produces subacromial stenosis. A recent cadaver study concluded that in the bodies with rotator cuff tear the acromial angle is very low. These studies indicate that anterior acromioplasty should be performed in case of impingement syndrome.

Internal impingement:

In throwing athlete, unstable shoulder and traction stress on the rotator cuff may lead to tear in the under surface of cuff tendon even without external impingement. In overhead athletes and throwers repetitive contact between under surface of the supraspinatus and posterosuperior glenoid in late cocking phase cause sharp posterior

shoulder pain. Dynamic stabilizer fatigue along with increased external rotation as a result of anterior capsular over stretch will lead to internal impingement.



Trauma:

Trauma results in articular sided tear most frequently than bursal tear. Trauma is due to direct injury to the affected side or repeated micro-trauma in athletes and in labourers due to repeated over head activity. Repetitive trauma will lead to minor injury within the cuff and no sufficient time is given to heal before next trauma. Because bursal side can bear more load, articular tear is more common. Deeper fiber tears retract since they will be on tension even with upper limb in rest. This results in tear progression. Multiple growth factors and neurotransmitters affect the tenocytes and their nuclei along with the collagen infrastructure of the rotator cuff tendon. Mechanically inferior tendon results due to cell death, reduced vascularity, defective tissue architecture and fibrocartilage with in the cuff. Mechanically inferior tendon along with repetitive microtrauma will lead to multiple smaller tear that undergo partial healing only.

CLASSIFICATION

Neer initially described three different stages of cuff lesions:

- Stage 1: Reversible edema and hemorrhage present in a patient younger than 25 years of age.
- Stage 2: Fibrosis and tendinitis affect the rotator cuff of a patient typically in the 25- to 40-years old age group. Pain recurs with activity.
- Stage 3: Bone spurs and tendon ruptures are present in a patient older than 40 years of age.

PARTIAL THICKNESS TEAR

1. **Ellman Classification :** considered a sub-classification of the stage 3 cuff lesion described by Neer

	Location	Grade	Footprint thickness involved	SIZE
A	Articular	1	less than quarter thickness	<3 mm
B	Bursal	2	more than a quarter to half thickness	3-6 mm
C	Interstitial	3	more than half thickness	>6 mm

2. Snyder et al. classification - based on arthroscopic findings.

A and B represent articular-sided, bursal-sided tear respectively

0	Normal rotator cuff with synovitis and/or bursitis
I	Slight inflammation with no lesion of tendons
II	Slight degeneration of tendon, without flap
III	Degeneration and fragmentation of tendon, good quality of the tendon tissue
IV	Wide lesion with degeneration and fragmentation of tendon or flap with two tendons involved

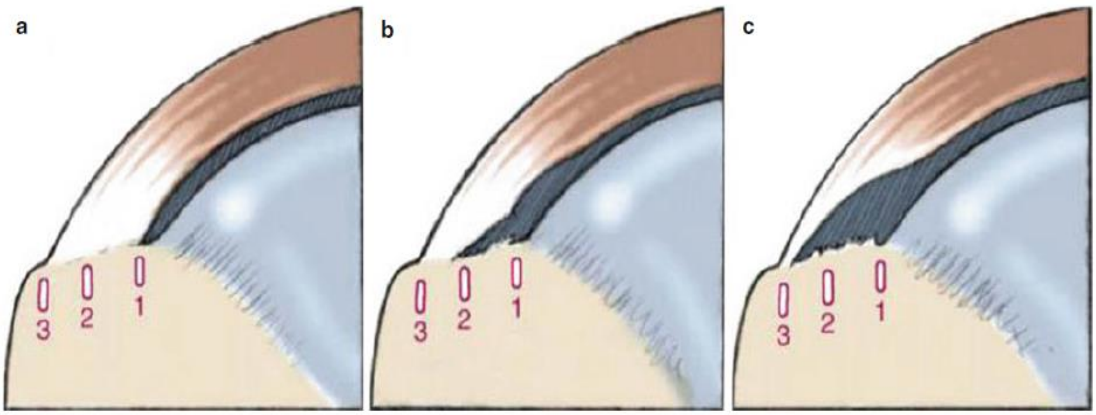
3. **Habermayer classification-** based on arthroscopic findings that not only accounts for size in the coronal plane but also accounts for the sagittal tear extension.

On coronal plane, lesions are divided into:

Type 1- Small tear within a transition zone from cartilage to bone

Type 2 -Extension of tear upto centre of the footprint

Type 3 -Extension of tear upto the greater tuberosity

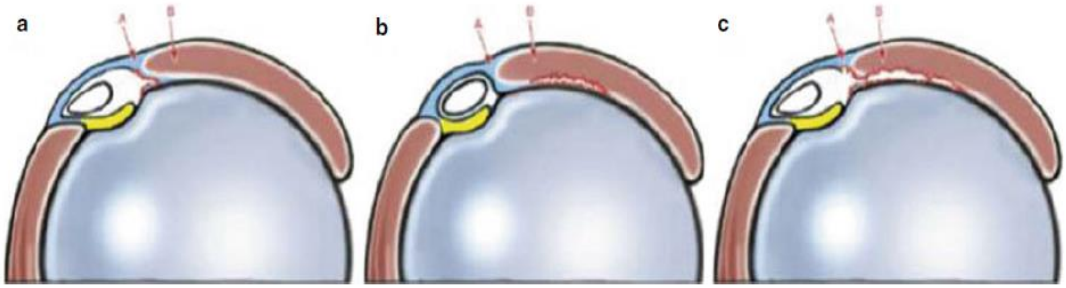


On the sagittal plane, the classification includes three types

Type A -Tear of coracohumeral ligament continuing into medial border of supraspinatus

Type B -Isolated tear within the crescent zone

Type C -Tear extending from the lateral border of pulley system over medial border of supraspinatus tendon up to area of crescent zone



FULL THICKNESS TEAR

1. **DeOrio and Cofield classification -** classified tears by the anterior-posterior length of the tendon that was torn off of the humeral head

Small	less than 1 cm
Medium	1 to 3 cm
Large	3 to 5 cm
massive	more than 5 cm

2. **Harryman classification-** based on number of tendons involved

Stage 0 - intact rotator cuff tendons

Stage IA - partial thickness tear of supraspinatus

Stage IB - full-thickness tear involving only supraspinatus.

Stage II - the supraspinatus and a portion of infraspinatus.

Stage III - supraspinatus, infraspinatus, and subscapularis tendons.

Stage IV - rotator cuff arthropathy.

3. **The Ellman and Gartsman classification-** based on tear shape

A - Crescent

B - reverse L

C - L-shaped

D - trapezoidal

E - massive full-thickness rotator cuff tear.

4. **Patte Classification-** based on the following criteria

1	Extent of Tears
2	Topography of Tears in Sagittal Plane
3	Topography of Tear in Frontal Plane
4	Trophic Quality of Muscle of Torn Tendons
5	State of the Long Head of Biceps

5. **Goutallier Classification of Fatty Infiltration**

Grade 0	Normal muscle without any fatty streaks
Grade 1	Muscle with some fatty streaking
Grade 2	Fatty infiltration is present, but less than muscle
Grade 3	Equal amount of fat and muscle tissues
Grade 4	More fat than the muscle

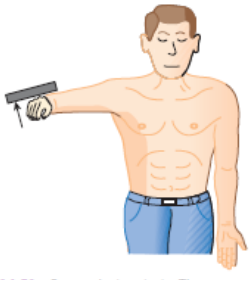
CLINICAL EVALUATION

Although some of the patients present with a sudden onset of symptoms following an acute shoulder injury, most of the patients with a pathologic condition of the rotator cuff have insidious onset of progressive pain and weakness, with concomitant loss of active motion. Pain is usually present at night and may be referred to the area of deltoid insertion. Passive motion initially remains full until the pain limits active motion enough to cause development of adhesive capsulitis. Most of the patients cannot recall a specific traumatic incident referable to onset of problems. Some asymptomatic tears become symptomatic later and some tears do progress in size. A study with bilateral rotator cuff tears found that, although all the patients were asymptomatic on one side at presentation, at follow-up over half had developed symptoms in the previously asymptomatic side. Medium-size tears have been shown to be at high risk of progression, whereas partial tears or small full-thickness tears appear to have little risk of early development of irreparable damage**.**

EXAMINATION: begins with visual inspection of supraspinatus and infraspinatus muscle bulk. Patients with chronic rotator cuff tears often have atrophy of muscle in the supraspinatus fossa or below the spine of the scapula when compared to the asymptomatic side.

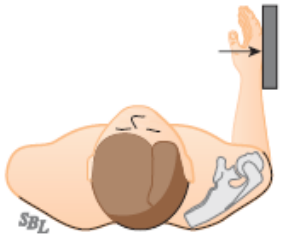
An assessment of passive and active motion arcs is made. Only the active motion is affected in patients with isolated rotator cuff pathology.

Supraspinatus: Isometric elevation of the arm held in 90 degrees of elevation in the plane of scapula and in mild internal rotation



Jobe's test

• *Infraspinatus:* Isometric external rotation of the arm held at the side in neutral rotation with elbow flexed to 90 degrees

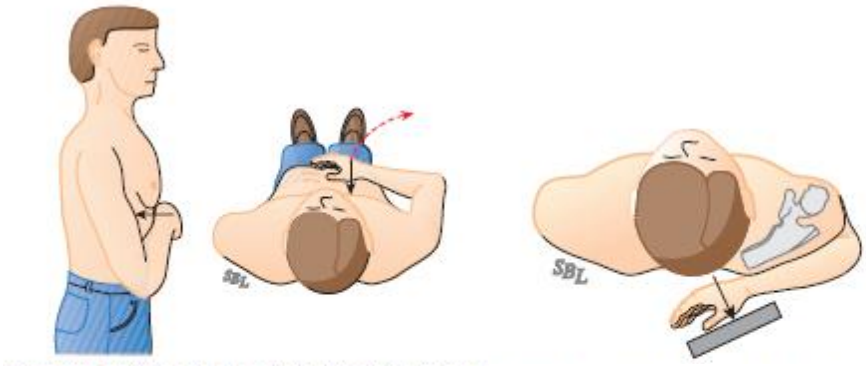


• *Teres minor:* Isometric external rotation of the arm in 90 degrees of abduction with elbow flexed to 90 degrees

Subscapularis: Isometric internal rotation of the arm with elbow flexed to 90 degrees and the hand pressing in toward the stomach; alternatively, isometric internal rotation of the arm with the back of the hand on the lumbar area

Belly press test

Lift off test



NEER'S IMPINGMENT SIGN: Examiner stands behind the patient and stabilizes the scapula with one hand on the acromion and with the other hand, the examiner elevates the patient's arm in the plane of the scapula. As the arm is brought into full elevation, the examiner holds down the scapula to prevent it from rotating superiorly, bringing the greater tuberosity into contact with the acromion and compressing the potentially inflamed supraspinatus tendon and bursa producing anterior shoulder pain.

NEER'S IMPINGMENT TEST: performed if the patient demonstrates a positive Neer impingement sign. Approximately 5 mL of 1% lidocaine is injected into subacromial space and after a few minutes

the Neer impingement manoeuvre is again performed. This test is considered positive when the pain associated with the preinjection Neer impingement sign is significantly reduced or absent, indicating that injected subacromial space was the source of pain.

HAWKINS KENNEDY IMPINGMENT TEST: patient's shoulder is placed in 90 degrees of forward flexion with elbow bent 90 degrees, and the examiner then forcibly internally rotates the arm . A positive Hawkins impingement sign is pain as the greater tuberosity rotates under acromion and coracoacromial arch, compressing the inflamed bursa and supraspinatus tendon.

PAINFUL ARC TEST - the patient elevates the arm in the scapular plane with the elbow straight, making sure that arm is kept in neutral rotation Alternatively, the arm can be placed in full elevation and the patient slowly brings down the arm to the side; positive painful arc test is documented when the patient experiences pain between 60 and 100 degrees of abduction during the manoeuvre.

RADIOLOGICAL EVALUATION

PLAIN RADIOGRAPH: can be obtained as a standard evaluation of any patient with suspected rotator cuff abnormality. These include an

- Anteroposterior (AP) view
- True AP in the scapular plane (Grashey view) in 30 degrees of abduction
- Scapular Y view
- An axillary view
- Scapular outlet view

Superior displacement of the humeral head in relation to the acromion and glenoid suggests that the rotator cuff is compromised. The scapular Y view can characterize acromial morphology.

An axillary view should be obtained with the arm in the scapular plane in neutral rotation and is important in assessing joint space narrowing associated with arthritis and anterior or posterior joint subluxation.

Scapular Outlet View: the patient is positioned as for a true scapulolateral radiograph, and the tube is angled caudally 10 degrees. This radiograph offers a view of outlet of the supraspinatus muscle–tendon unit as it passes under the coracoacromial arch. Deformities of anteroinferior acromion or acromioclavicular arch down into the outlet

can be noted on this view. Bigliani and colleagues identified three distinct acromial shapes based on this radiologic view.

ULTRASOUND

USG showed good sensitivity (84%) and specificity (89%) for the assessment of PTT and FTT (sensitivity 0.96; specificity 0.93). A steep learning curve, operator and technique dependence with inaccuracies in measuring tear size and PTT are few drawbacks of USG. Nonetheless it remains a reliable, fast, accurate, cost and time-saving tool in experienced hands and allows instant comparison with contralateral side, dynamic evaluation of tendons and quantitative and qualitative assessment of fatty infiltration.

High frequency (10-18 MHz) transducers are used for the shoulder. Normal tendon should appear uniformly echoic with a fibrillar pattern when the transducer is perpendicular to the tendon axis. As the normal tendon is anisotropic, when the beam is not perpendicular to the tendon, a hypoechoic signal appears. The tendon should be interpreted as abnormal only if the area maintains a hypoechoic signal when the transducer is moved perpendicular to the tendon axis. A focal hypoechoic area can diagnose partial- and full-thickness tearing with discontinuity of the normal fibrillation pattern of tendons.

MRI

The MRI can provide vital information and outstanding details not only on the rotator cuff tear size, extent, location, retraction, fatty infiltration and muscle atrophy, but also on long head of biceps, acromial morphology, AC joint and subacromial space. A prospective follow-up of 48 patients revealed 100% positive predictive value of MRI in detecting surgical tears. The MRI thus has an edge over USG in detecting smaller tears and possibly better evaluation of PTT.

T1-weighted images highlight fat, and aid in assessing fatty infiltration associated with chronic rotator cuff tears. If a tear is identified, fatty infiltration and atrophy of the muscle belly are to be evaluated on the T1-weighted sagittal oblique images as a method to grade chronicity and the likely reparability of the tear. PD and T2-weighted imaging aid in assessing the integrity of the rotator cuff tendons. Fat saturation highlights fluid edema in T2 image. Partial- and full-thickness tears demonstrate high signal intensity on T2-weighted images.

Other, less frequently utilized and indication-specific modalities of imaging include

-plain radiographs with arthrography

-computed tomography scans and

-MRI arthrography.

PREVALENCE

The true incidence of partial-thickness tears is unknown. Most of the information is from cadaver studies, which reflect an older population; the true incidence in young overhead-throwing athletes is unknown. Among partial thickness tears, cadaver studies indicate that intratendinous tears are more common than articular-sided or bursal-sided tears, whereas a clinical study found that articular-sided tears constituted 91% of all partial-thickness tears in a population of young athletes. This discrepancy between cadaver and clinical studies may result because intratendinous tears are more difficult to diagnose with arthroscopy, MRI, or ultrasound than are bursal-sided or articular-sided tears.

Cadaveric Studies

Many studies cited in literature do not specify the age of the cadavers examined; this explains why the prevalence of the cuff tear varies from 5 to 44%.

In 1834, Smith [1], examined 40 cadavers whose age was not mentioned, observed the full thickness rotator cuff tear in seven cases (18 %). After about a century, Keyes [2] stated that the prevalence was 19 %.

In modern era, the lowest percentages reported in literature are the ones of Cotton [3] (8 %) and Neer [4] (5 %), deduced from studies carried out in 1964 and in 1983, respectively.

Examining 219 shoulders, Yamanaka et al. [5] reported a prevalence of partial and full thickness tears of 13 % and 8.4 %, respectively. Of all partial tears, 3 % were on bursal side, 3 % were on articular side, and 7 % were intratendinous.

Otherwise, De Palma [10] and Uhthoff [11], examining 192 and 612 shoulders, affirmed that 75 % and 50 % of the subjects had a cuff tear. In these two series, the prevalences of partial tears were 58% and 37%, whereas the ones of full thickness tears were 9% and 20%.

Yamanaka et al. [5] and Fukuda et al. [6 – 8] observed that the prevalence of a partial or full thickness lesion was 0 % in the subjects younger than 40 years old, 30 % in those older.

Differently, Lehman et al. [9] asserted that prevalence was 6 % in subjects younger than 60 years old and 30 % in those more elderly.

Studies on Asymptomatic Subjects

Milgrom et al. [46] have performed 180 ultrasound scans of shoulders on 90 asymptomatic subjects and have observed partial and full thickness tears in 18 % and 17 % of cases, respectively. In addition, the authors have stated that the prevalence of the tears increases with the age

of the patients and is greater than 80 % in subjects with more than 80 years old.

In a similar study, performed on 411 shoulders of asymptomatic subjects that had more than 50 years old, Tempelhof [32] observed full thickness tears in 23 % of the cases. Sher et al. [33] have subjected to MRI evaluation of 192 asymptomatic shoulders (96 subjects). The authors have observed a partial or a complete cuff tear in 20 % and in 15 % of the cases, respectively. Furthermore, they have shown that the prevalence of tears increases with the age and it is 4 % in subjects younger than 40 years and 54 % in those older than 60 years . Other authors have observed a prevalence of cuff lesions between 5 and 36 %.

Studies on Symptomatic Patient- The studies of Crass et al [57] and Minagawa et al [56] have enrolled big populations of patients: 500 and 1328 shoulders, respectively. In both, the prevalence of rotator cuff tear has been 22%. Moreover, Minagawa et al. have divided their population in age-related groups and have shown that the ones aged less than 50 years had a prevalence of tears of 0 %, the ones aged between 50 and 59 of 11 %, between 60 and 69 of 15 %, and between 70 and 79 of 26 %. The prevalence in patients of more than 80 years raised up to 37 %.

Study on Mixed Population (Asymptomatic and Symptomatic)

Yamamoto[54] in 2010 has studied 683 patients from a little Japanese city by echography (1366 shoulders). The population included

subjects aged between 22 and 87 years old (mean 58 years). The prevalence of full thickness rotator cuff tear has been 21%, dropping to 17% in asymptomatic patients and increasing to 36% in symptomatic ones. Even in this study the prevalence increased with age reaching 80 % in patients aged more than 80.

METHODOLOGY

AIM:

- To study about the prevalence of rotator cuff tear by cadaveric study in a small group of physically active population

OBJECTIVE:

- To study about the prevalence of rotator cuff tear **(supraspinatus and infraspinatus)** by cadaveric study in a small group of physically active population in order to evaluate the increasing incidence of cases of chronic shoulder pain in younger population .
- The purpose of this study was to elucidate the true prevalence of rotator cuff tears regardless of the presence or absence of symptoms in a small group of physically active population from 20-50 years of age.
- To aid in acknowledging the importance of aetiology of chronic shoulder pain in younger population.

DESIGN: prevalence study

PERIOD: August 2015 to September 2017

INCLUSION CRITERIA:

1. Fresh cadavers (time since death not exceeding 24hours)
2. Age from 20 to 50 years
3. Physically active by work/occupation
4. Both sexes and both shoulders

EXCLUSION CRITERIA:

1. Decomposed cadavers
2. Cadavers with time since death elapsed more than 24hours.
3. Cadavers with ipsilateral upper limb injuries :
    - Soft tissue injuries
    - Fractures
    - Dislocated shoulders
    - Burns injury

MATERIALS & METHODS

This prevalence survey was undertaken in the Department of Orthopaedics, Madurai Medical College & Govt. Rajaji Hospital, TamilNadu in concurrence with the Department of Forensic Medicine and the Department of Pathology, Madurai Medical College, Madurai, between August 2015 and September 2017.

With the approval of the Ethical Committee and the Department of Forensic Medicine, rotator cuff sections were dissected from cadavers in the Department of Forensic Medicine at Govt. Rajaji hospital, Madurai. In this study, rotator cuff specimens were studied macroscopically while dissecting and then microscopically in the Department of Pathology at Madurai Medical College, Madurai.

We were provided with the details of the subjects regarding name, age, sex, nature of the profession and evidence of any injury in the upper limb. No information on the lifestyle of the subjects, on the history of shoulder complaints and on the hand dominance was available. All autopsies were performed within 24 hours after death. Rotator cuff muscles (supraspinatus and infraspinatus) were dissected from fresh cadavers of both sexes, on both sides excluding those with soft tissue or bony injuries in the upperlimb, regardless of the cause of death. 100

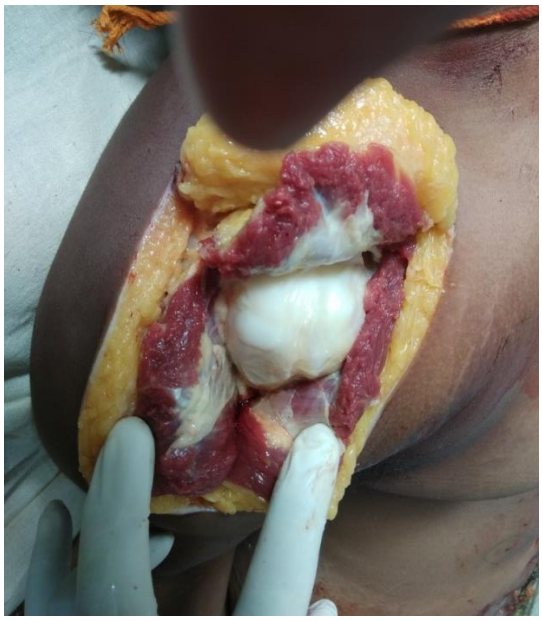
rotator cuff specimens were dissected from 54 cadavers with age at death between 20 to 50 years (average age- 33.7 years).

ROTATOR CUFF DISSECTION

With the subject lying supine and sandbag under the ipsilateral scapula to expose the shoulder posteriorly, we proceeded dissection after excluding soft tissue or bony injury in the ipsilateral shoulder and upper limb.

Made dissection by beginning at the anterior aspect of the shoulder along the anterior margin of the lateral one third of the clavicle and extended around the acromion laterally and along the lateral half of the spine of the scapula posteriorly and along the anterior margin of the deltoid muscle to a point two thirds the distance between its origin and insertion.

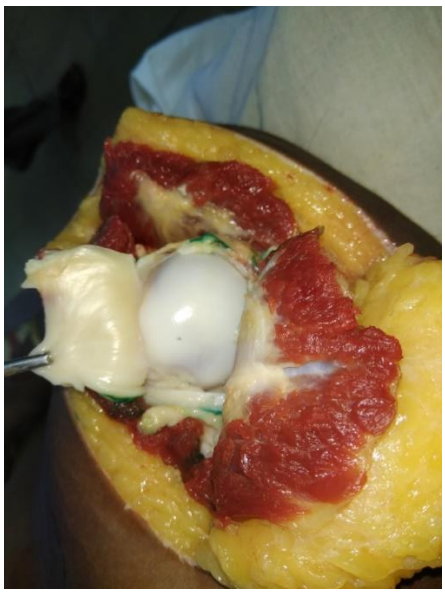

Detached the origin of the deltoid from the scapula and clavicle, and reflected it laterally to visualise the anterior, superior, and posterior parts of the bursal surface of rotator cuff.




Rotator cuff muscles (subscapularis, supraspinatus, infraspinatus and teres minor) were inspected for any obvious lesion on the bursal (nonarticular) surface. Scapula was inspected for the presence of hooked acromion process.

Supraspinatus and infraspinatus muscles (full thickness) were marked for about 3*3 cm dimension just along their insertion into greater tuberosity laterally & the anterior margin of supraspinatus anteriorly.

Marked region of rotator cuff is dissected except along their insertion laterally and the dissected part is reflected to expose the articular surface and examined for any macroscopic tear.

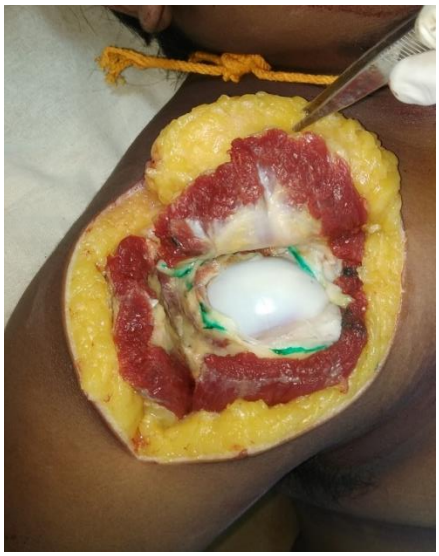


Free medial end is now tagged along the bursal side with yellow thread for left side and red thread for right shoulder. Now the lateral end is also sectioned.

ARTICULAR SURFACE

BURSAL SURFACE

Inferior surface of acromion is now palpated to rule out hooked acromion.Section is fixed in 10% formalin solution and sent for histopathological examination.



PATHOLOGICAL EXAMINATION

Histopathological examination of Rotator cuff specimens was done in the Department of Pathology at Madurai Medical College, Madurai. From each specimen, 3 slides were prepared; one each from bursal side, articular side and intratendinous portion. Histological examination was done to find out the microscopic tear on bursal or articular side or intratendinous tear as indicated by Hashimoto in 2003

- collagen fiber disorientation,
- chondroid metaplasia, fibroblast proliferation,
- fatty degeneration, inflammatory cell infiltration, myxoid degeneration

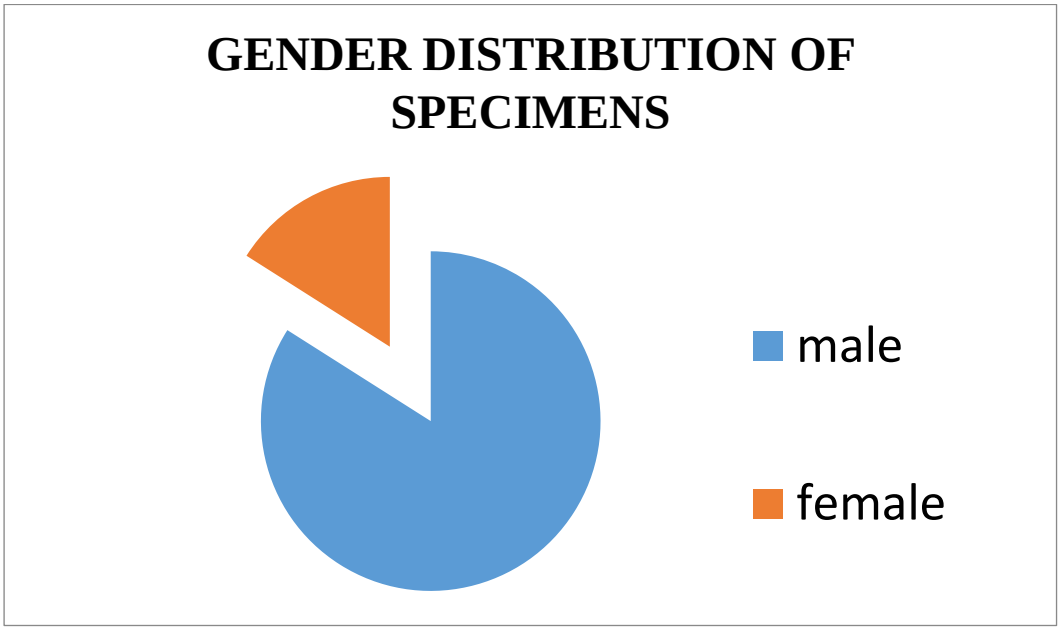
OBSERVATION & RESULTS

1. GENDER DISTRIBUTION

A total of 100 cadaveric sections[84 male shoulders (84%) and 16 female shoulders (16%)] obtained from 54 subjects(male- 45;female-9) aged 20 -50 years at the time of death with a mean age of 33.7 years, were included in our study .

TABLE 1 –GENDER DISTRIBUTION

Gender	No. of subjects	Percentage of subjects	No. of specimens	Percentage of specimens (%)
Male	45	83.33	84	84
Female	9	16.66	16	16
Total	54		100	

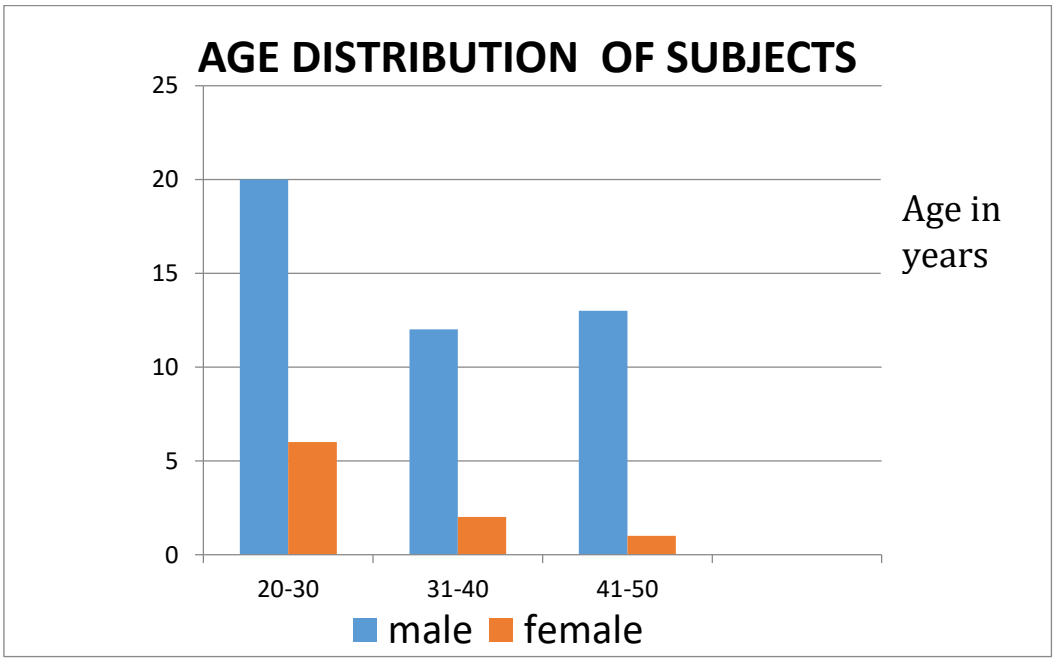


2.AGE DISTRIBUTION:

Among the 54 subjects studied, highest number of patients was seen in 20-30 years (57.1%) age group. The average was 33.7 years.

TABLE 2 –AGE DISTRIBUTION OF SUBJECTS

Age (years)		No. of subjects	No. of shoulders	% of shoulders	
20 - 30	M	20	39	50	50 %
	F	6	11		
31 – 40	M	12	22	25	25%
	F	2	3		
41 – 50	M	13	23	25	25%
	F	1	2		
Total		**54**	**100**		



3. DISTRIBUTION OF MACROSCOPIC TEAR

Among 54 subjects (100 shoulders), only 3subjects (5 shoulders) had macroscopic tear. 2 subjects had bilateral macroscopic tear. One subject had tear on left shoulder (right shoulder of that subject was excluded from dissection). All those 5 macroscopic tears were partial thickness -articular tears and involving male subjects only. None of them were associated with hooked acromion.

TABLE 3 –macroscopic tear- age distribution

Age (years)	No of subjects with macroscopic tear	Percentage of subjects with macroscopic tear	No of specimens with macroscopic tear	Percentage of specimens with macroscopic tear
20 – 30	-	0%	-	0%
31 – 40	1	7.14%	2	8%
41 – 50	2	14.28%	3	12%
Total	**3**	**5.55%**	**5**	**5%**

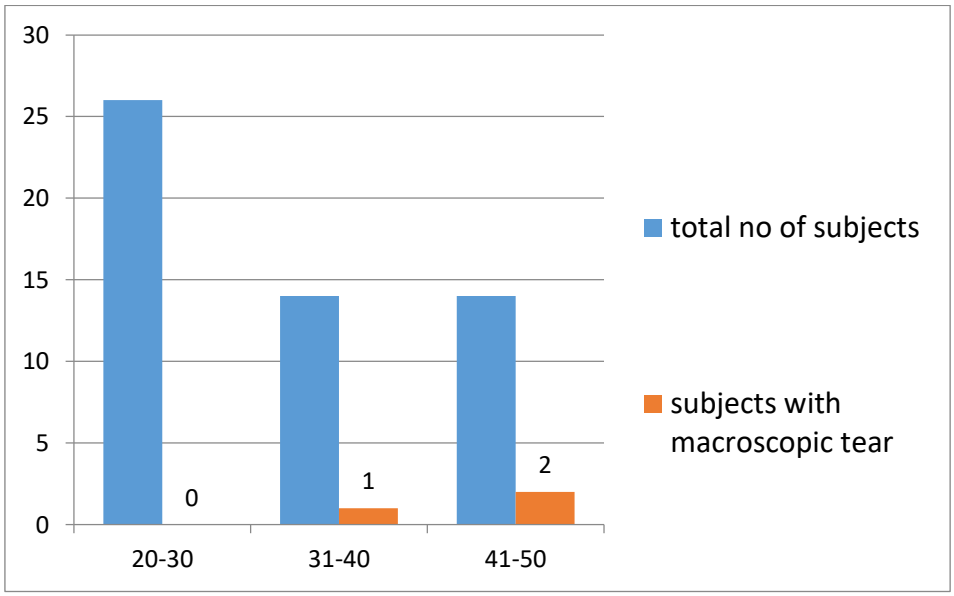
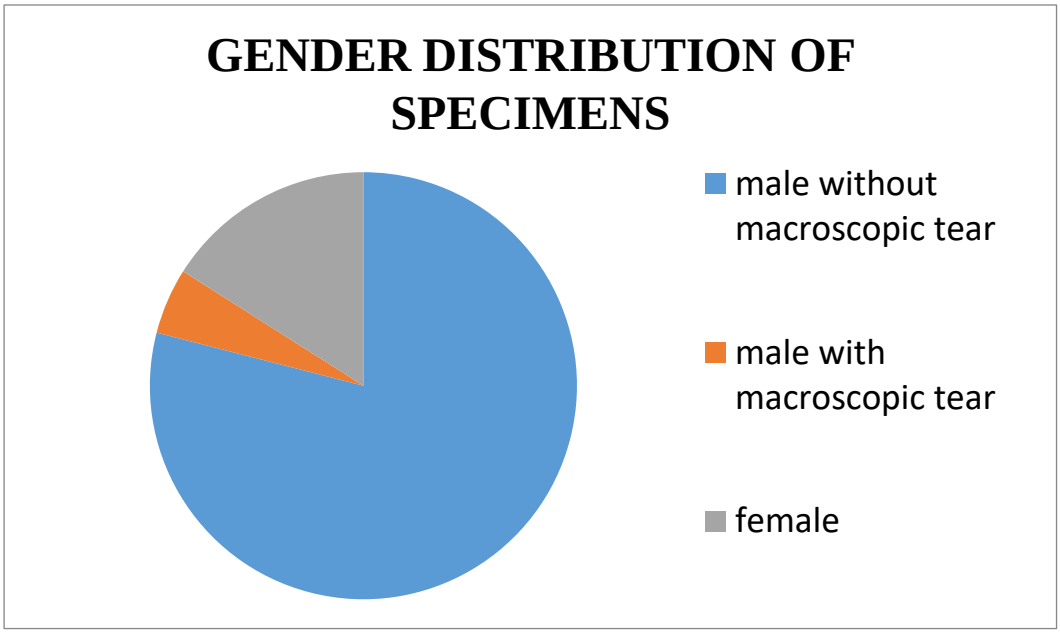


TABLE 4 –macroscopic tear- gender distribution

Gender	No. of specimens	No. of specimens with macroscopic tear	Percentage of specimens (%)
Male	84	5	5.95%
Female	16	0	0
Total	100	5	5%



4. HOOKED ACROMION: In our study, among 54 subjects, only one male subject had hooked acromion on both shoulders. Prevalence of hooked acromion is 1.85%. On microscopic examination, both specimens had collagen disorientation, chondroid metaplasia, and inflammatory infiltrates with fibroblast proliferation in their bursal side suggestive of partial thickness bursal tear.

TABLE 5 –age prevalence of hooked acromion

Age (years)	No. of subjects	No. of subjects with hooked acromion	Percentage of subjects with hooked acromion
20 - 30	26	-	-
31 – 40	14	1	7.14%
41 – 50	14	-	-
Total	**54**	**1**	**1.85%**

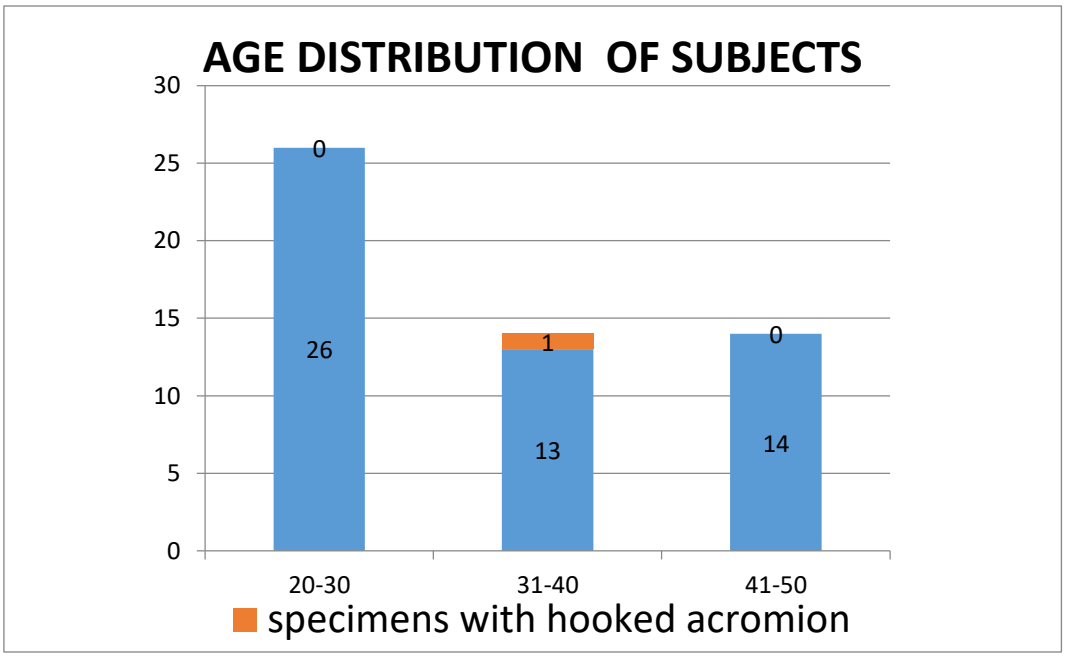


TABLE 6 –gender prevalence of hooked acromion

Gender	No. of cadavers	No. of cadavers with hooked acromion	Percentage of cadavers with hooked acromion
Male	45	1	2.22
Female	9	-	-
Total	54	1	1.85%

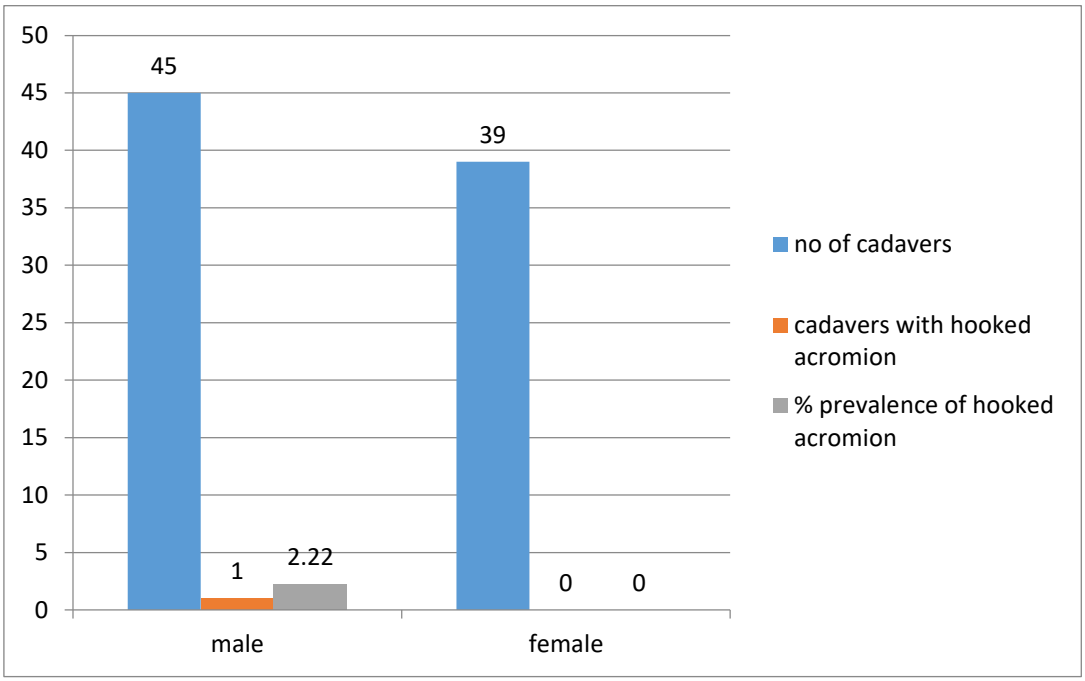
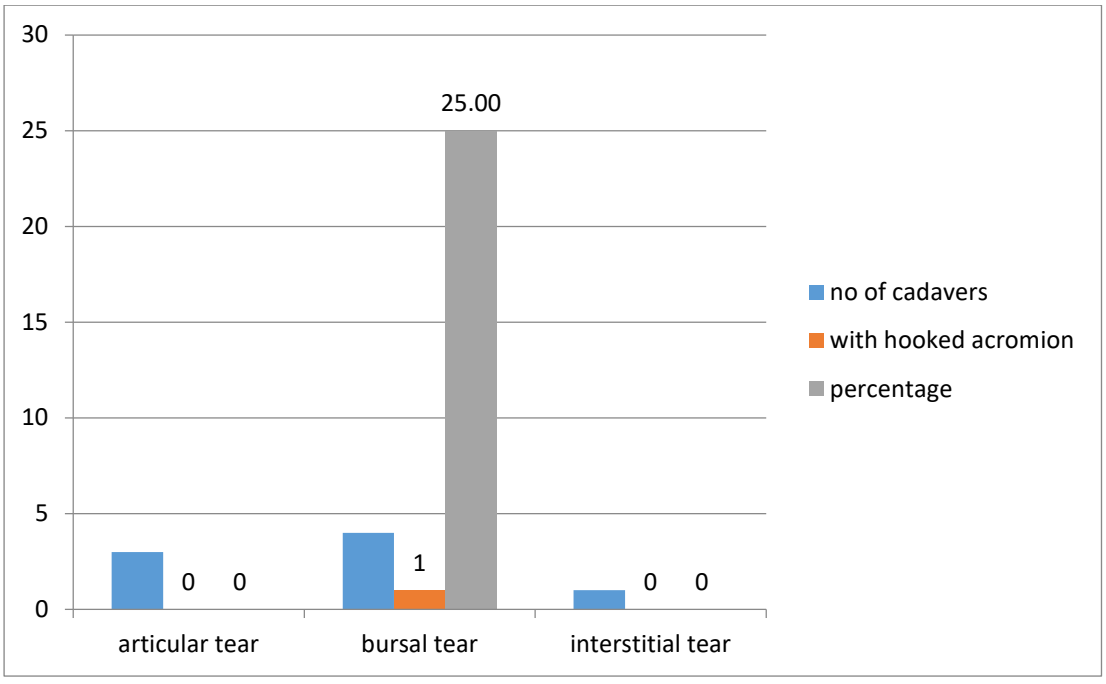


TABLE 7 –prevalence of hooked acromion in torn rotator cuff

Site of tear	No of subjects with tear	No of subjects with tear having hooked acromion	Percentage of cadavers with hooked acromion
Articular	3	-	0
Bursal	4	1	25%
Interstitial	1	-	0
Total	8	1	12.5%

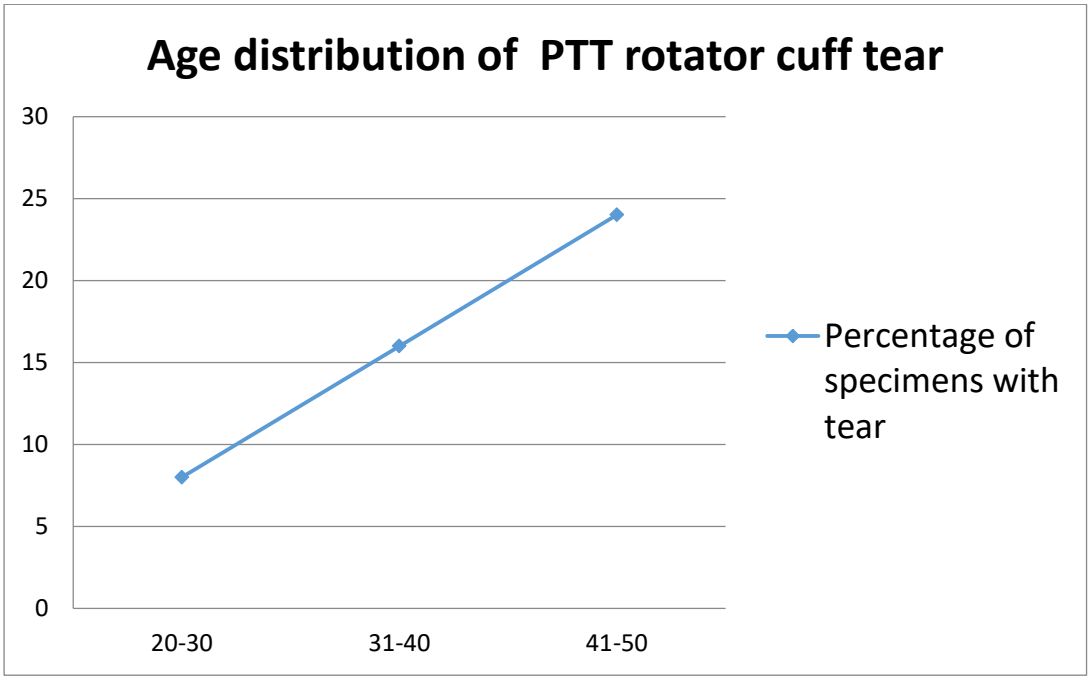


4. MICROSCOPIC TEAR :

The prevalence of RCT was found to be 14.8% and was highest among the age group 41-50 years (28.57%) followed by 31-40 years population (14.28%) and least in 20-30 years population (7.69%) with all being partial thickness tear.

TABLE 8–AGE DISTRIBUTION OF PTT ROTATOR CUFF TEAR

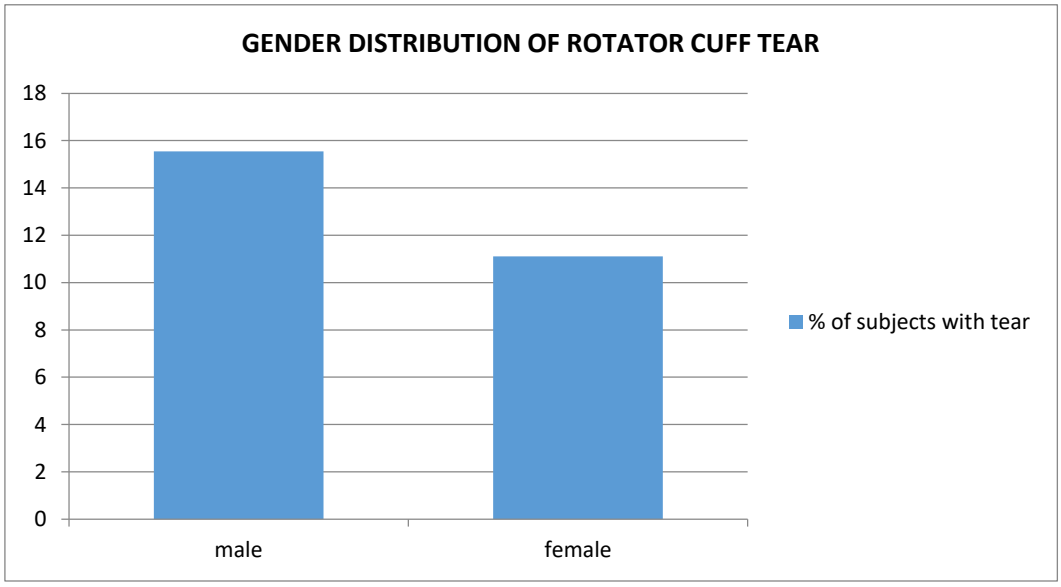
AGE (YEARS)	No. of subjects	No. of subjects with tear	Percentage of subjects with tear
20 - 30	26	2	7.69%
31 – 40	14	2	14.28%
41 – 50	14	4	28.57%
TOTAL	**54**	**8**	**14.8%**



PTT was most commonly prevalent among males (15.55%) than females (11.11%) but it was not satistically significant as p value is >0.05 as analysed by chi-square test.

TABLE 9 –GENDER DISTRIBUTION OF ROTATOR CUFF TEAR

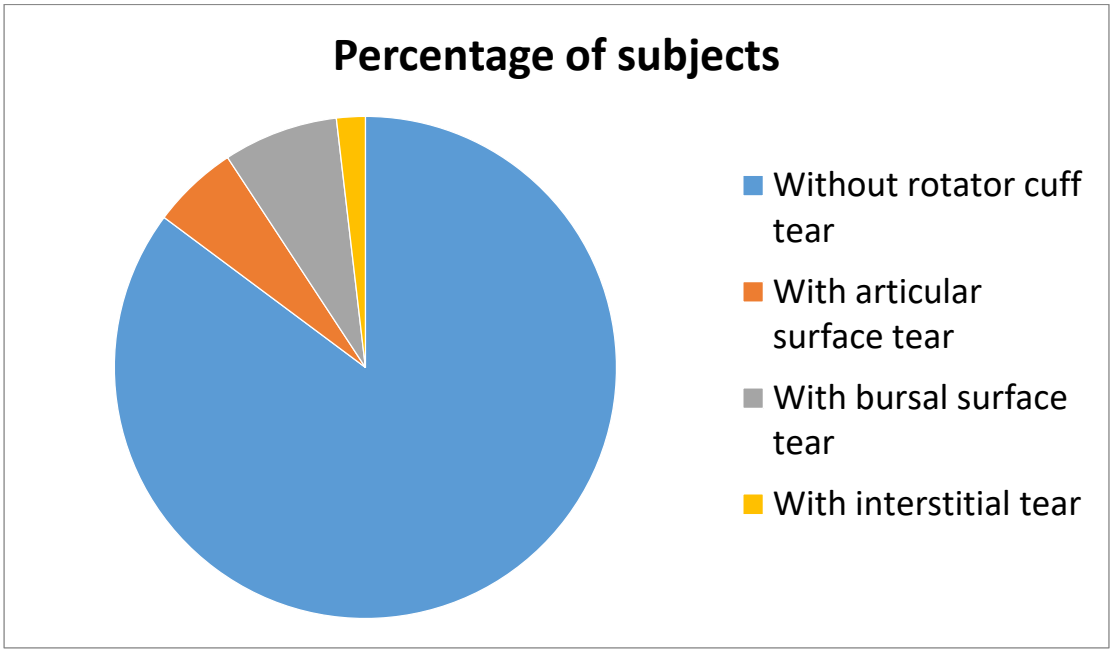
Gender	No of subjects	No. of subjects with tear	Percentage of subjects with tear (%)
Male	45	7	15.55%
Female	9	1	11.11%
Total	54	8	14%



Partial thickness tear was more common along the bursal surface (7.40%), followed by articular tear (5.56%) and least in the interstitium (1.85%).

TABLE 10 – SITE DISTRIBUTION OF ROTATOR CUFF TEAR

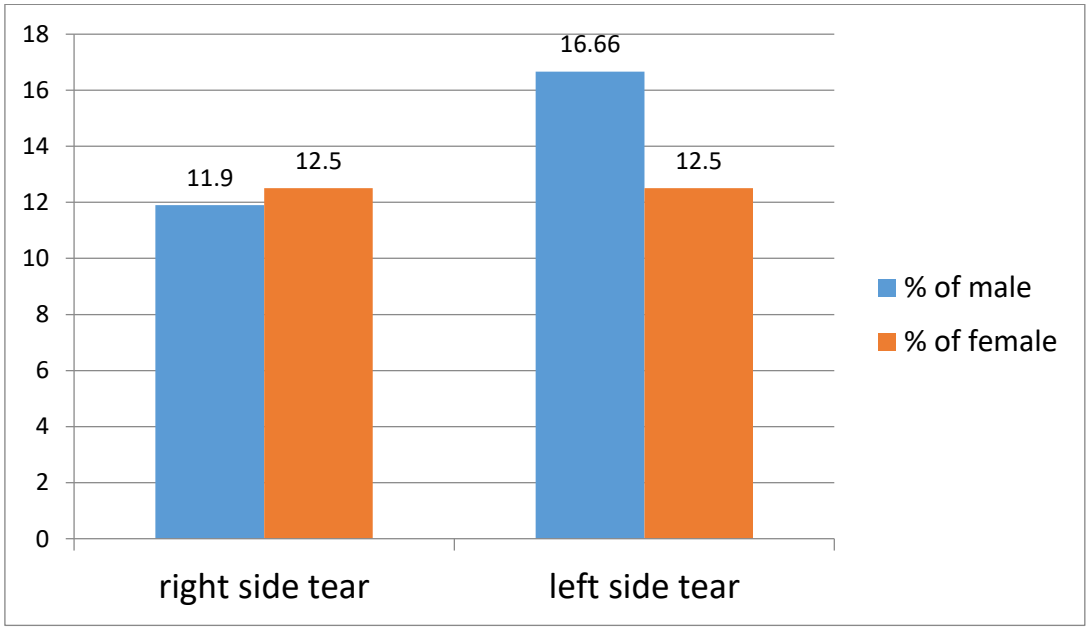
Site of tear	No. of subjects with rotator cuff tear	Percentage of subjects (%) with rotator cuff tear	No. of Shoulders with rotator cuff tear	Percentage of shoulders (%)with rotator cuff tear
Articular	3	5.56 %	5	5 %
Bursal	4	7.40 %	8	8 %
Interstitial	1	1.85 %	1	1 %
Total	8	14.8%	14	14%



Left sided prevalence of PTT (16%) was more than the right sided PTT (12%) since right shoulder was excluded from the study in 2 subjects.

TABLE 11 – SIDE DISTRIBUTION OF ROTATOR CUFF TEAR

side		No of specimens	No. of specimens with tear	Percentage of specimens with tear (%)	
Right	M	42	5	11.9%	12%
	F	8	1	12.5	
Left	M	42	7	16.66%	16%
	F	8	1	12.5	
Total		100	14	14%	



The prevalence of PTT was highest among the age group 41-50 years (28.57%) followed by 31-40 years population (14.28%) and least in 20-30 years population (7.69%).

TABLE 12 – AGE DISTRIBUTION OF PARTIAL THICKNESS TEAR

Age in years	No. of subjects	No of subjects with			Percentage of subjects (%) with		
		articular tear	Interstitial tear	Bursal tear	articular tear	Interstitial tear	Bursal tear
20-30	26	-	-	2	-	-	7.69%
31-40	14	1	-	1	7.14%	-	7.14%
41-50	14	2	1	1	14.28%	7.14%	7.14%

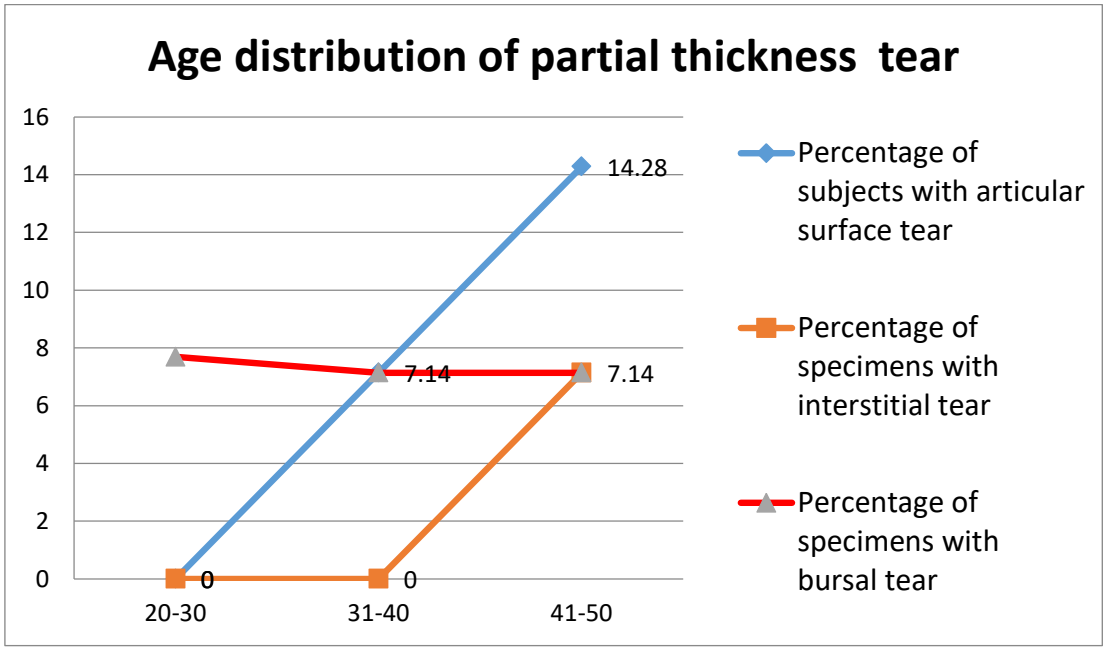


TABLE 13 – GENDER DISTRIBUTION OF PARTIAL THICKNESS TEAR

Gender	No. of subjects	No. of subjects with			Percentage of subjects (%) with		
		Articular tear	interstitial tear	Bursal tear	Articular tear	interstitial tear	bursal tear
Male	45	3	1	3	6.66%	2.22%	6.66%
Female	9	0	0	1	0	0	11.1%

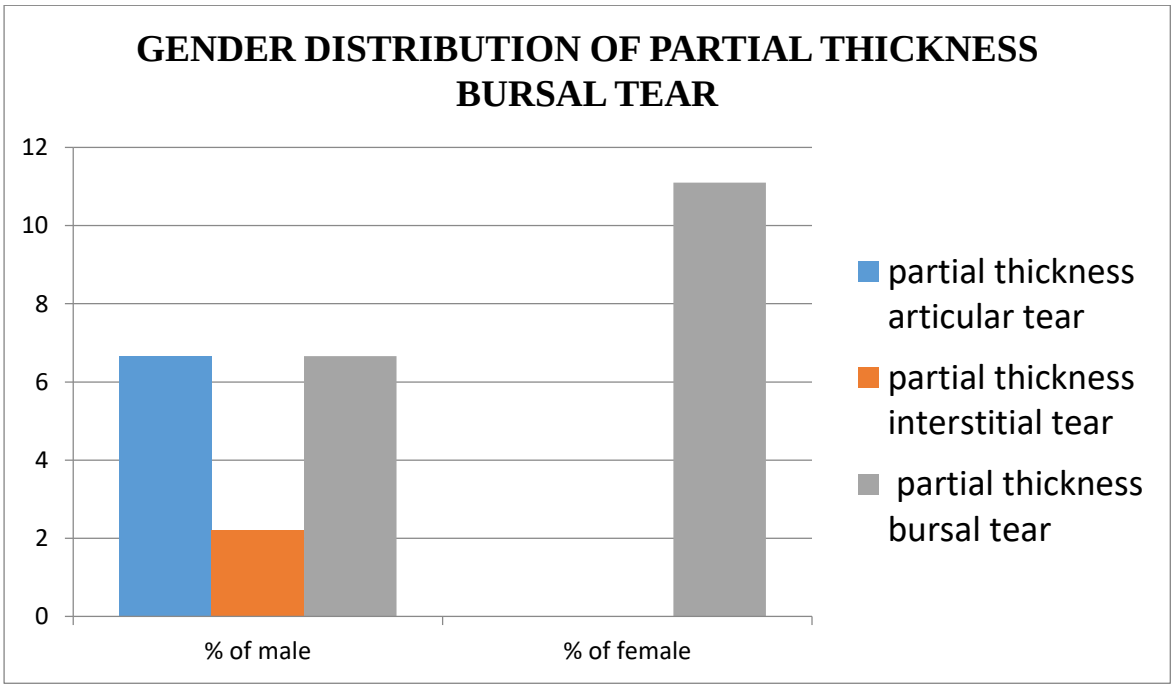
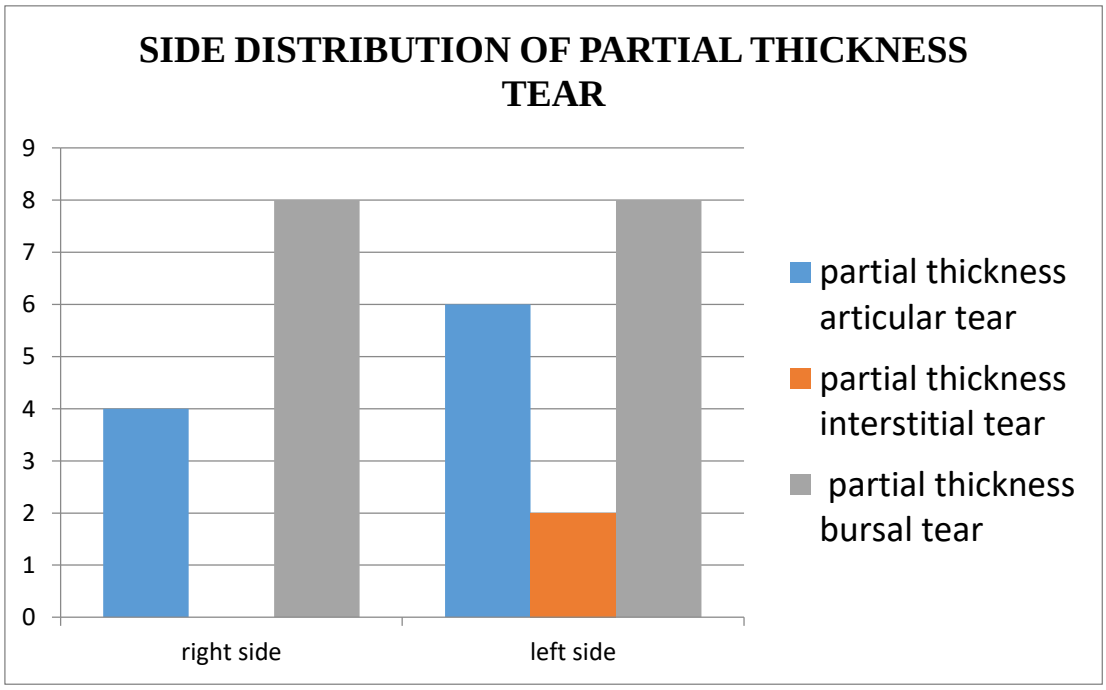


TABLE 14 – SIDE DISTRIBUTION OF PARTIAL THICKNESS TEAR

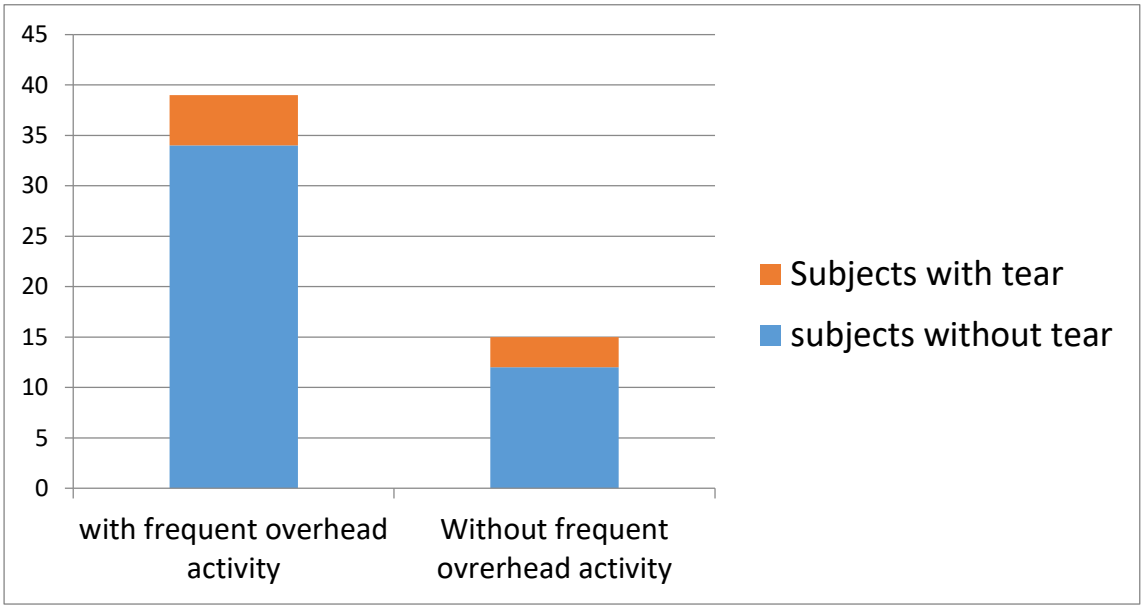
Side	No. of specimens	No. of specimens with			Percentage of specimens (%) with		
		Articular tear	interstitial tear	Bursal tear	Articular tear	interstitial tear	bursal tear
Right	50	2	0	4	4%	0%	8%
Left	50	3	1	4	6%	2%	8%
Total	100	5	1	8	5%	1%	8%



6. OCCUPATIONAL DISTRIBUTION

In this we categorize the occupation of the subjects into 2 categories one who are manual labourers requiring frequent overhead activities (construction workers, mechanics, cleaners, metalworkers, painters, farmers, etc.) and those who do not require frequent overhead activity like businessmen, professionals, retailers, housewives.

	Total no. of subjects	**Subjects with tear**			**% of subjects with tear**
		articular	**interstitial**	**bursal**	
with frequent overhead activity	39	3	-	2	12.8%
Without frequent overhead activity	15	-	1	2	20 %



RESULTS:

In this study, 100 cadaveric rotator cuff specimens (84 male, 16 female) from 54 cadavers (male- 45; female- 9) aged 20 -50 years at the time of death, with a mean age of 33.7 years, were analyzed for the prevalence of rotator cuff tear. Of the 54 cadavers, rotator cuff specimens were dissected bilaterally from 46 cadavers and unilaterally from 8 cadavers, as the contralateral side was excluded due to soft tissue and bony injuries of the upper limb. Among the specimens dissected, 50 specimens were from each shoulder. The subjects were categorized by age from 20 to 50 years as 20-30, 31-40 and 41-50 years. 50% of specimens were obtained from the age group of 20-30 years and the other two groups contain 25% of specimens each.

Histopathological examination revealed the presence of rotator cuff tear in 14 specimens from 8 subjects (14.8%), of which 5 specimens from 3 subjects had macroscopic tear, all being partial thickness tears. None of the specimens had full thickness tear.

Among the 54 subjects, 3 subjects (5.56%) had macroscopic rotator cuff tear, of which 2 had bilateral tear and 1 had tear on left shoulder (Right shoulder of the subject excluded from dissection), and all the 3 subjects were male (6.67%). All those 5 macroscopic tears were partial thickness articular tears and the same was confirmed histopathologically. None of them was associated with hooked acromion.

The prevalence of PTT was highest among the age group 41-50 years (28.57%) followed by 31-40 years population (14.28%) and least in 20-30 years population (7.69%).

PTT was most commonly prevalent among males (15.55%) than females (11.11%). But this difference is insignificant as the p-value is more than 0.05.

Partial thickness tear was more common along the bursal surface (7.40%), followed by articular tear (5.56%) and least in the interstitium (1.85%). Left sided prevalence of PTT (16%) was more than the right sided PTT (12%) since right shoulder was excluded from the study in 2 subjects.

Articular tears were more prevalent in the age group of 41-50 years (14.28%), followed by 31-40 years population (7.14%) and these were found only in male subjects in our study (6.66% of male subjects). Left sided prevalence (60%) was more than the right sided PTT (40%) since right shoulder was excluded from the study in 1 subject.

Prevalence of bursal tears does not differ within the age groups significantly with 7.69% in 20-30 years and 7.14% in both 31-40 and 41-50 years populations. Bursal tears equally involve both the shoulders.

Interstitial tear was detected only in 1 male subject (2.22%) in the age group 41-50 years (7.14%) and involving the left shoulder as right shoulder was excluded from the study.

Of the 8 subjects with rotator cuff tear, bilaterality was seen in all the 6 subjects (100%) excluding those 2 subjects in whom dissection was done on one side only.

The prevalence of hooked acromion is 1.85% as only 1 subject presented bilaterally and the same subject had PTT on both sides along the bursal surfaces. This shows significant association of bursal tear with the presence of hooked acromion (25%).

The influence of occupation requiring overhead activities has no effect on rotator cuff tears as evident from the study that tears among those with frequent overhead activities is 12.8% and those who do not is 20%.

SUBJECT 1

S.NO - 31

Age at death/sex: 24/F

Occupation : HOME MAKER

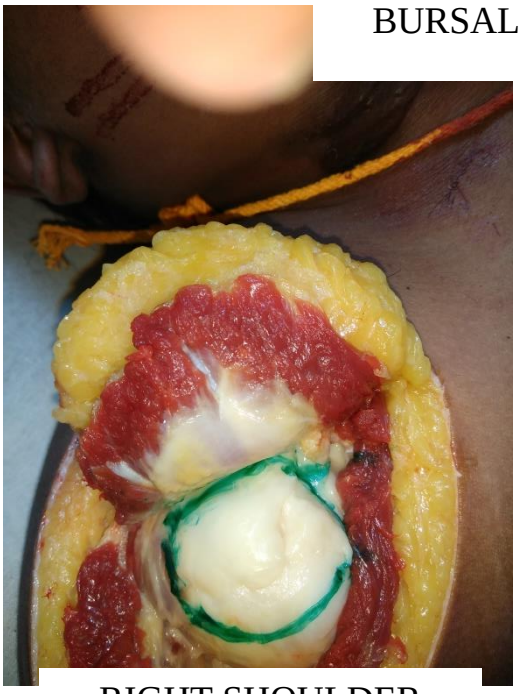
Specimen : BILATERAL

Macroscopic : NO TEAR

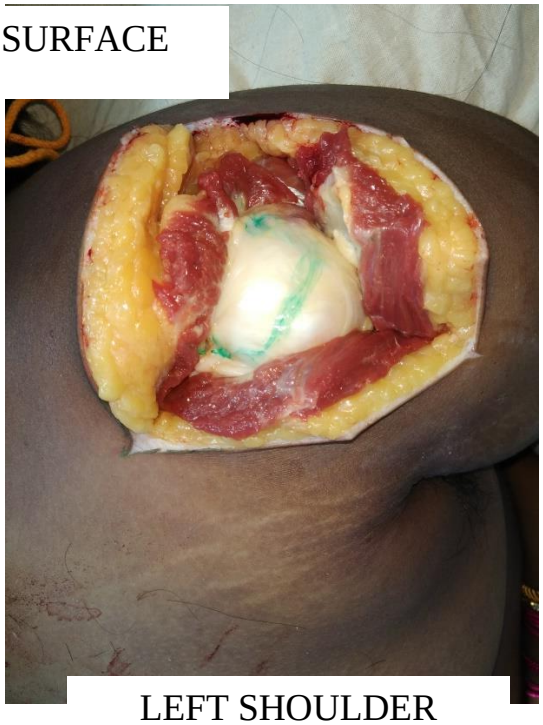
Hooked acromion : ABSENT

Microscopic: B/L BURSAL TEAR

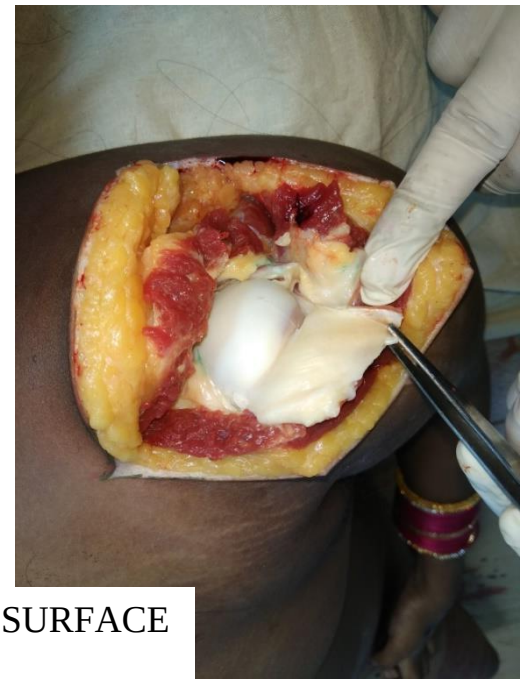
BURSAL SURFACE



RIGHT SHOULDER

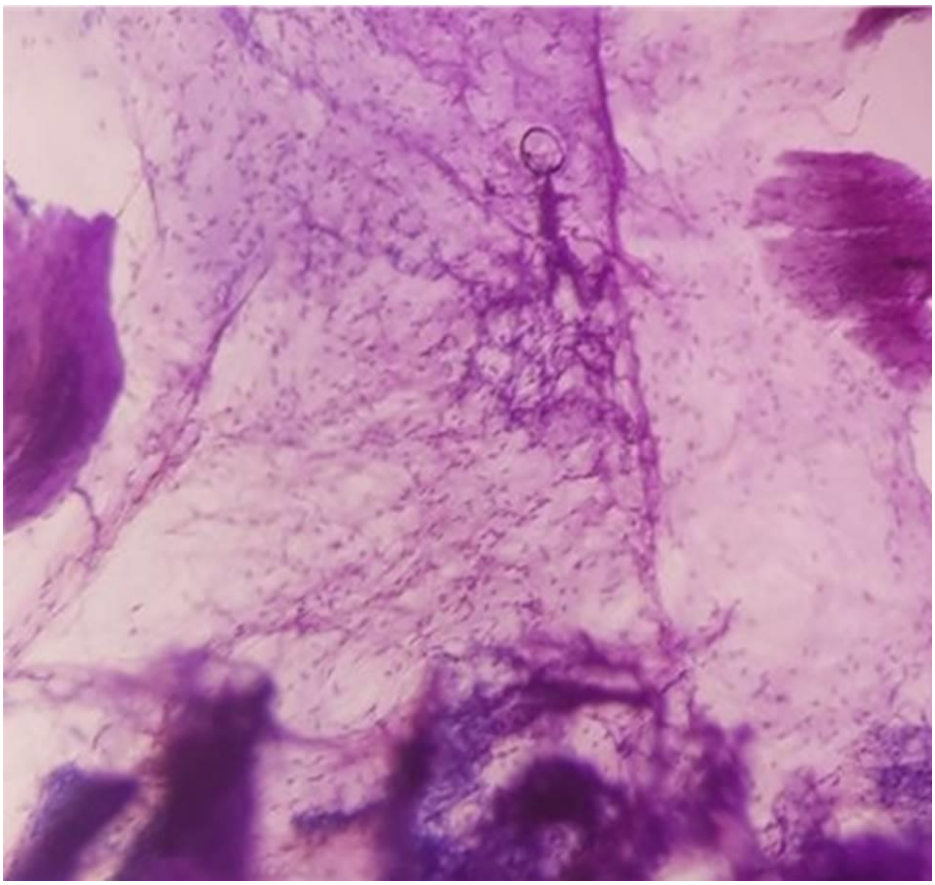


LEFT SHOULDER



ARTICULAR SURFACE

ARTICULAR SURFACE BURSAL SURFACE



Bursal slide showing myxoid degeneration with focal chondroid metaplasia (right). H&E stain, original magnification x 10.

SUBJECT 2

S.NO- 5

Age at death/sex: 21/ M

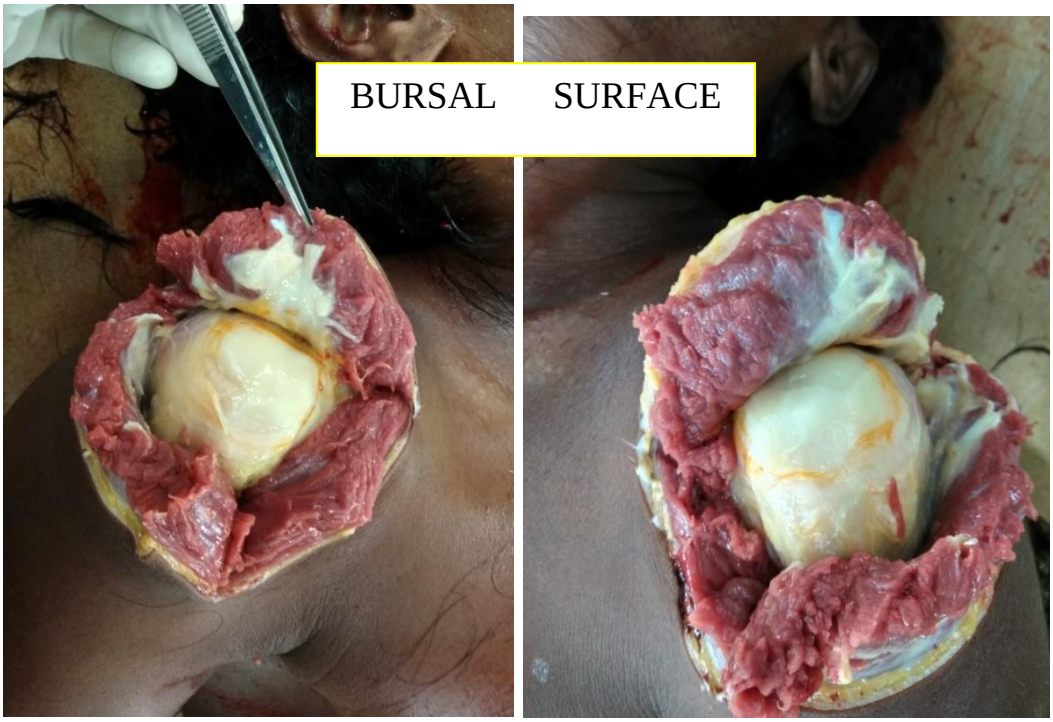
Occupation : MANUAL LABOURER

Specimen : BILATERAL

Macroscopic : NO TEAR

Hooked acromion : ABSENT

Microscopic: NO TEAR



RIGHT SHOULDER

LEFT SHOULDER

ARTICULAR SURFACE

SUBJECT 3

S.NO- 22

Age at death/sex: 25/ M

Occupation : MANUAL LABOURER

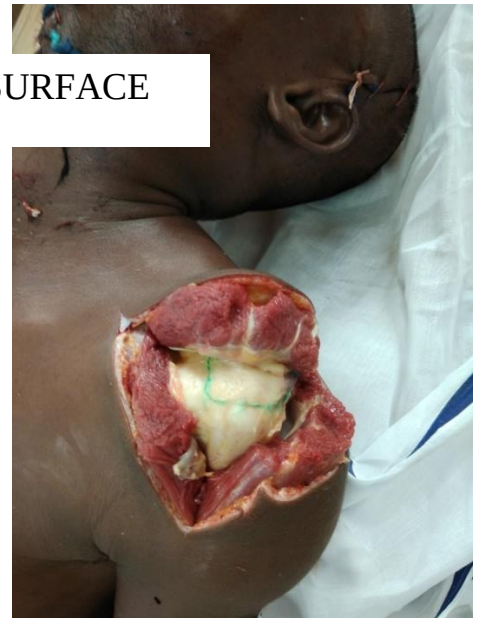
Specimen : BILATERAL

Macroscopic : NO TEAR

Hooked acromion : ABSENT

Microscopic: B/L BURSAL TEAR

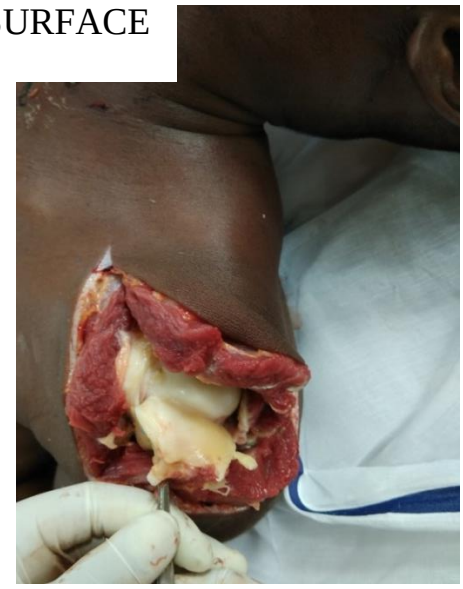
BURSAL SURFACE



RIGHT SHOULDER

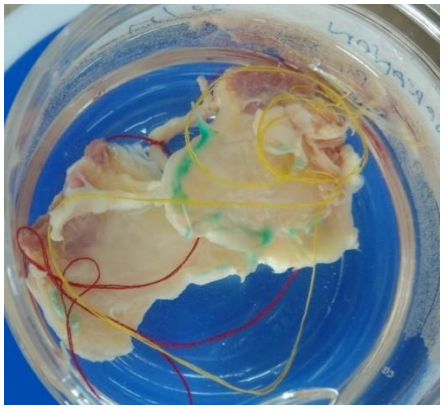
LEFT SHOULDER

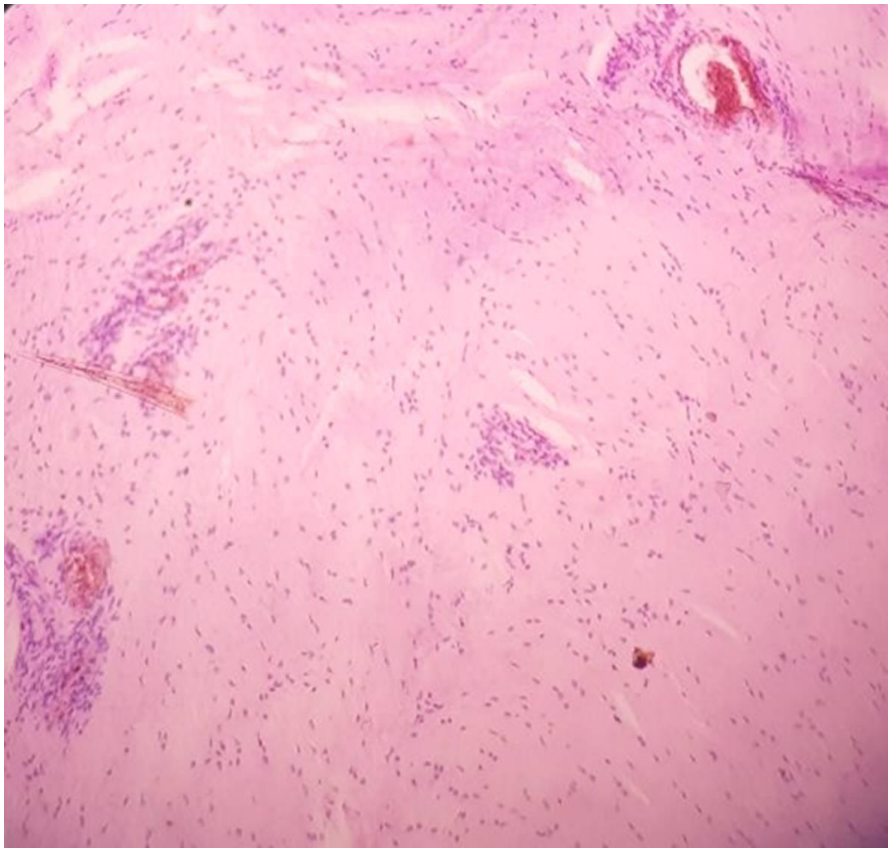
ARTICULAR SURFACE



BURSAL SURFACE

ARTICULAR SURFACE





Bursal slide showing vascular proliferation changes noted in the tendon. H&E stain, original magnification x10

SUBJECT 4

S.NO- 53

Age at death/sex: 27/ M

Occupation : PROFESSIONAL

Specimen : BILATERAL

Macroscopic : NO TEAR

Hooked acromion : ABSENT

Microscopic: NO TEAR

BURSAL SURFACE

ARTICULAR SURFACE

SUBJECT 5

S.NO- 14

Age at death/sex: 34/M

Occupation : MANUAL LABOURER

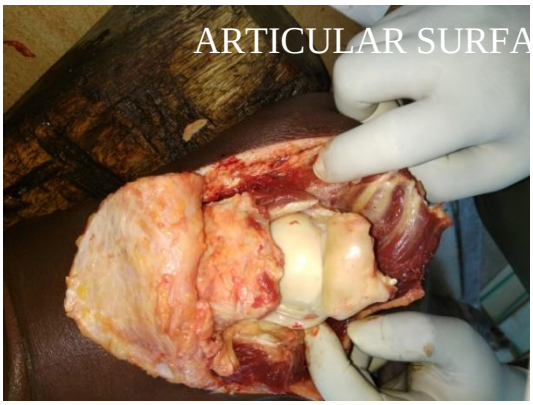
Specimen : LEFT SIDE

Macroscopic : NO TEAR

Hooked acromion : ABSENT

Microscopic: NO TEAR

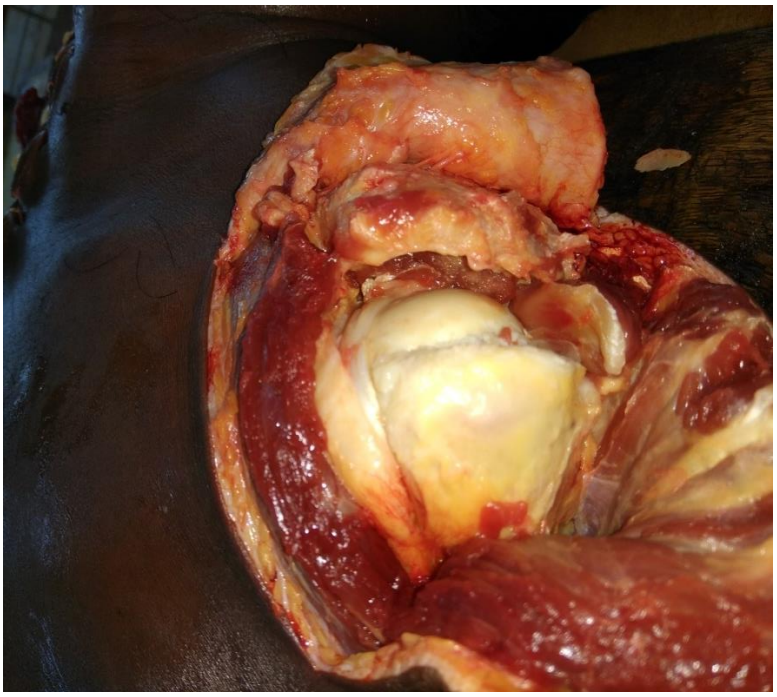
LEFT SHOULDER



ARTICULAR SURFACE

BURSAL SURFACE

ANTEROPOSTERIOR VIEW SHOWING NORMAL FLAT ACROMION AFTER RETRACTING ROTATOR CUFF MUSCLES



LATERAL VIEW SHOWING THE UNDERSURFACE OF ACROMION AFTER DISSECTING ROTATOR CUFF MUSCLES

S.NO- 20

SUBJECT 6

Age at death/sex: 40/M Occupation :RETAILER

Specimen : BILATERAL Macroscopic : NO TEAR

Microscopic: B/L BURSAL TEAR

Hooked acromion : PRESENT BILATERALLY

RIGHT SHOULDER LEFT SHOULDER

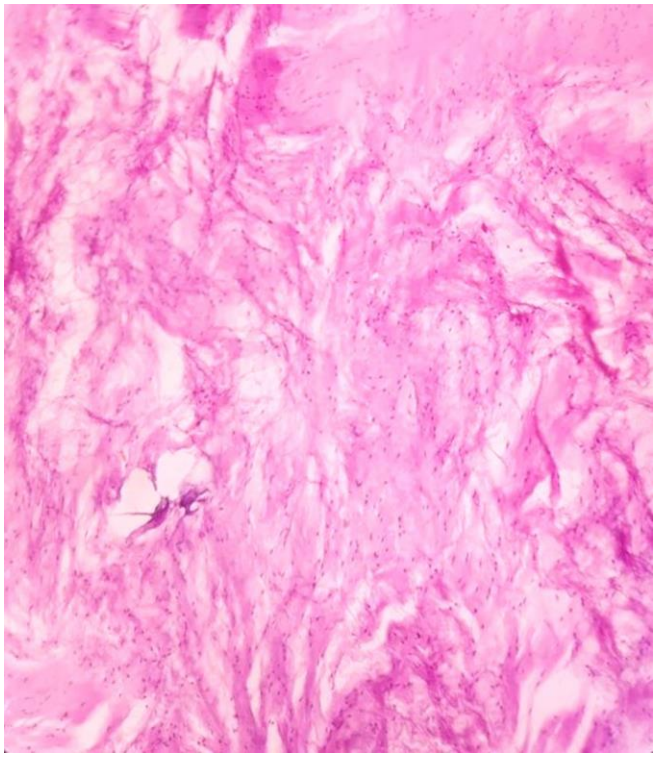
Left & Right shoulders showing hooked acromion

- Inability to visualise the inferior surface of acromion in lateral view of scapula

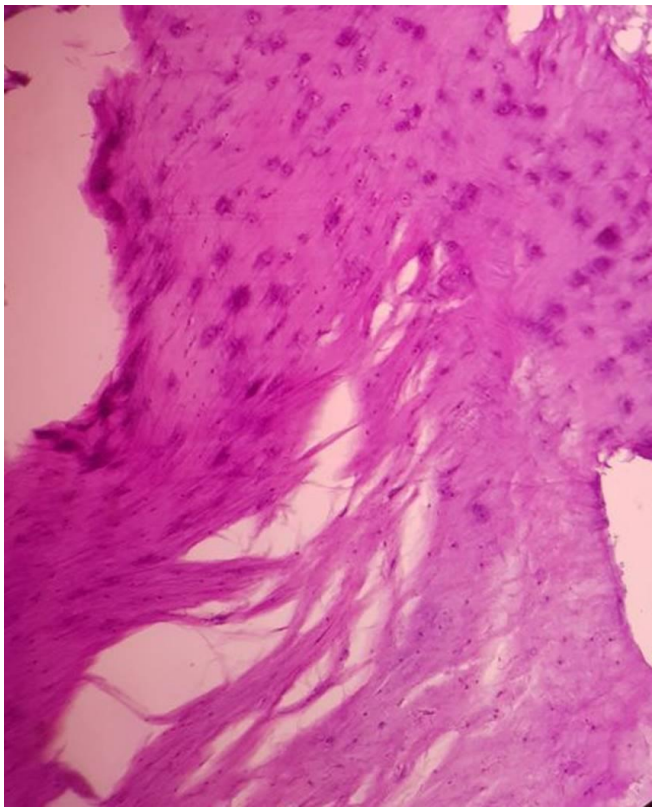
Left & Right shoulders showing hooked acromion

-with curving of lateral end of acromion downwards in anteroposterior view

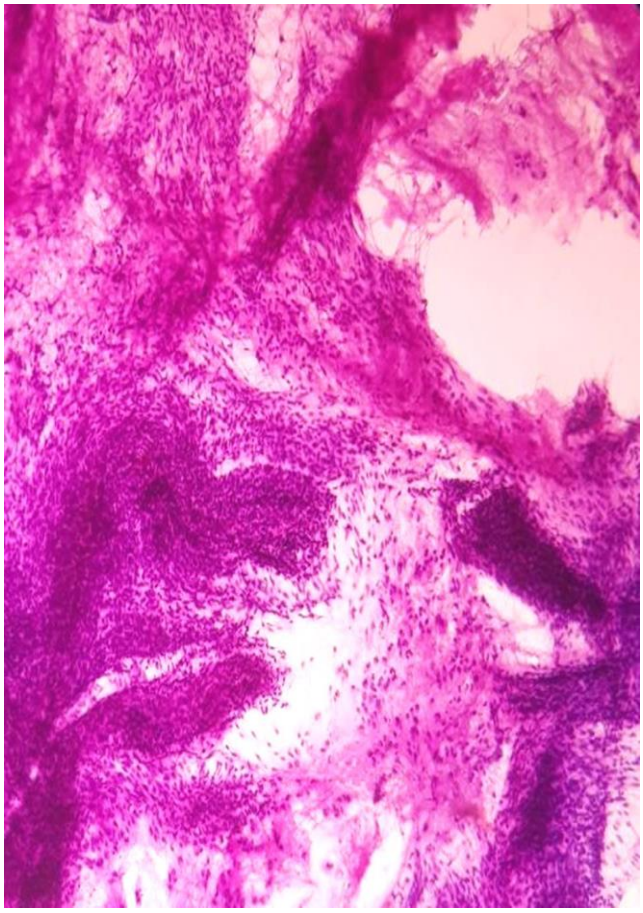
- reduced acromiohumeral distance and



Bursal slide showing disoriented collagen fibres in torn tendon, H&E stain, original magnification x 10.



Bursal slide showing significant chondroid metaplasia with focal myxoid degeneration of collagen fibres in torn tendon, H&E stain,



Bursal slide showing fibroblast proliferation along with inflammatory cells and foci of scant necrosis (top right). H&E stain, original magnification x10

SUBJECT 7

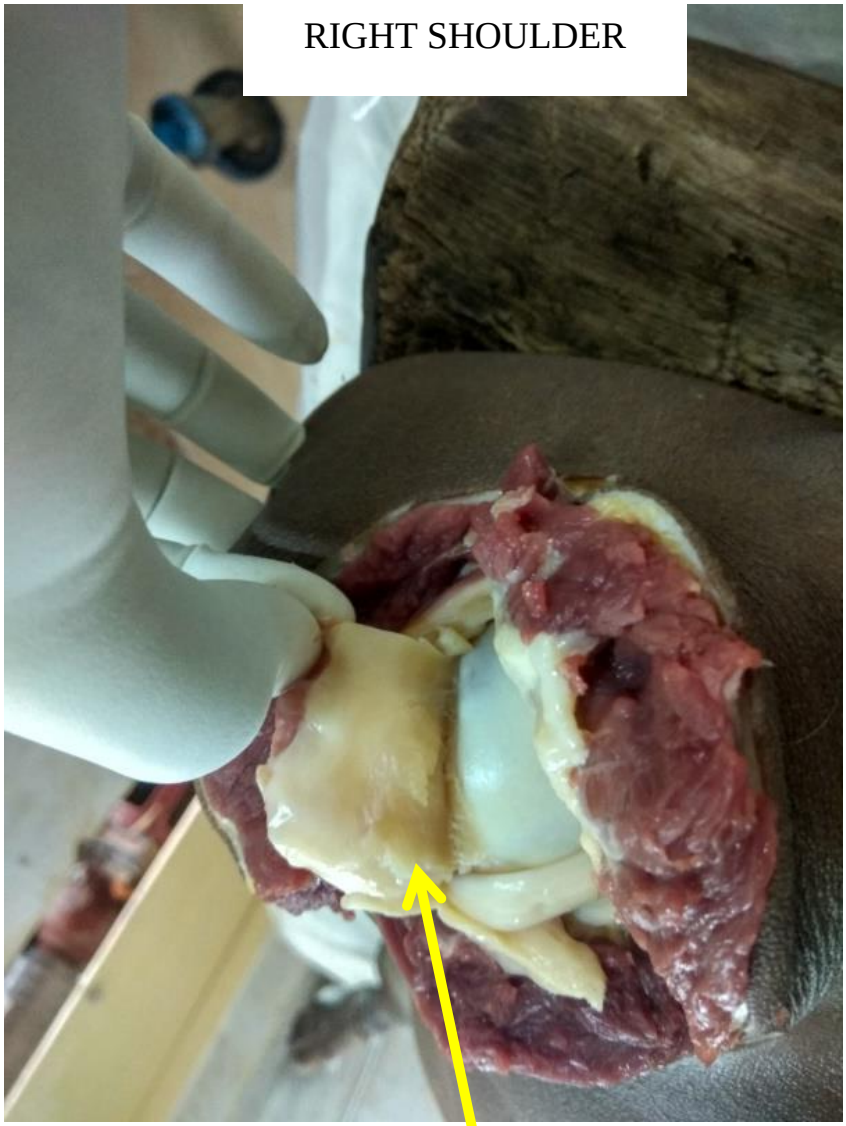
S.NO – 42

Age at death/sex: 40/M Occupation : MANUAL LABOURER

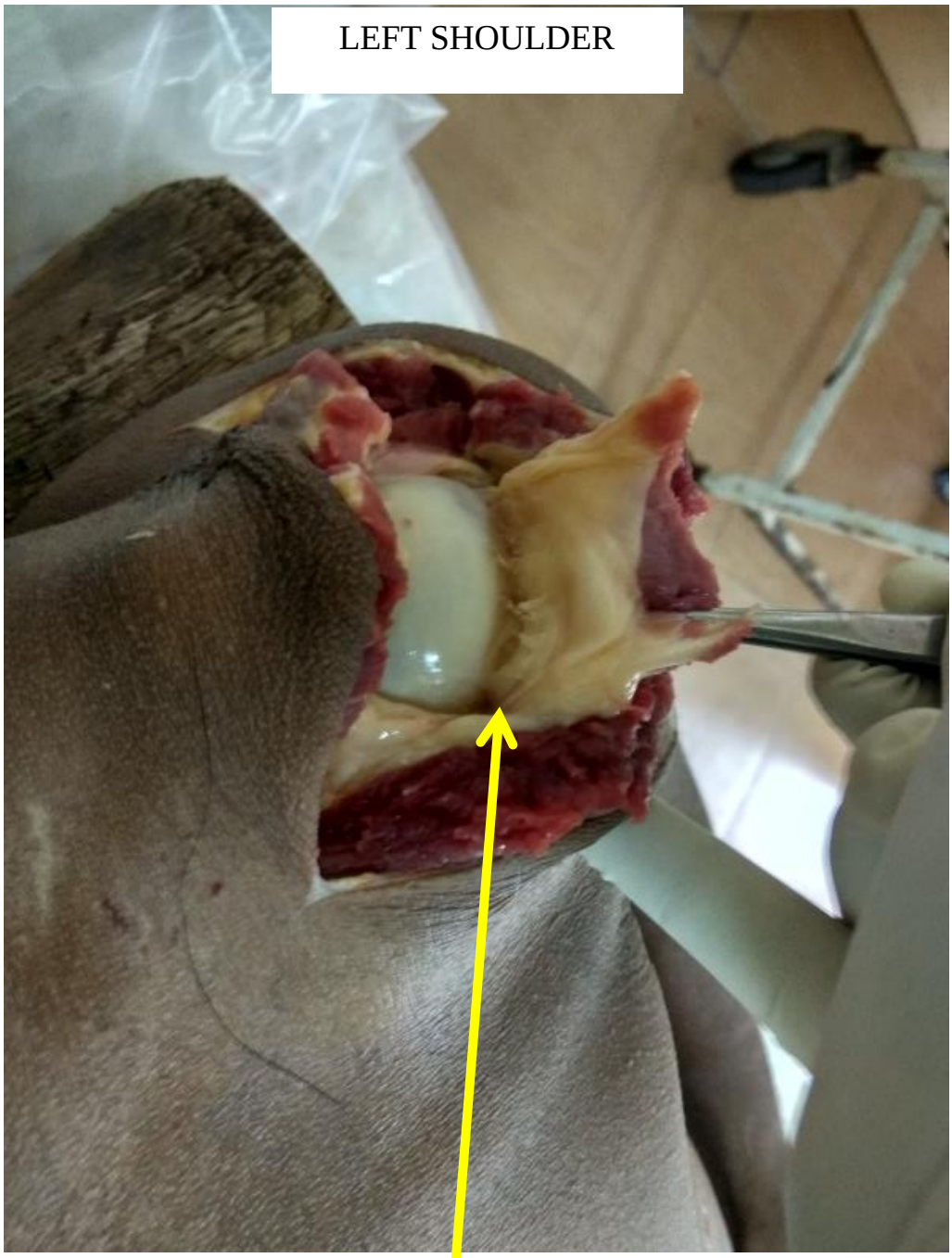
Specimen : BILATERAL Macroscopic : B/L ARTICULAR TEAR

Hooked acromion : ABSENT Microscopic: B/L ARTICULAR TEAR

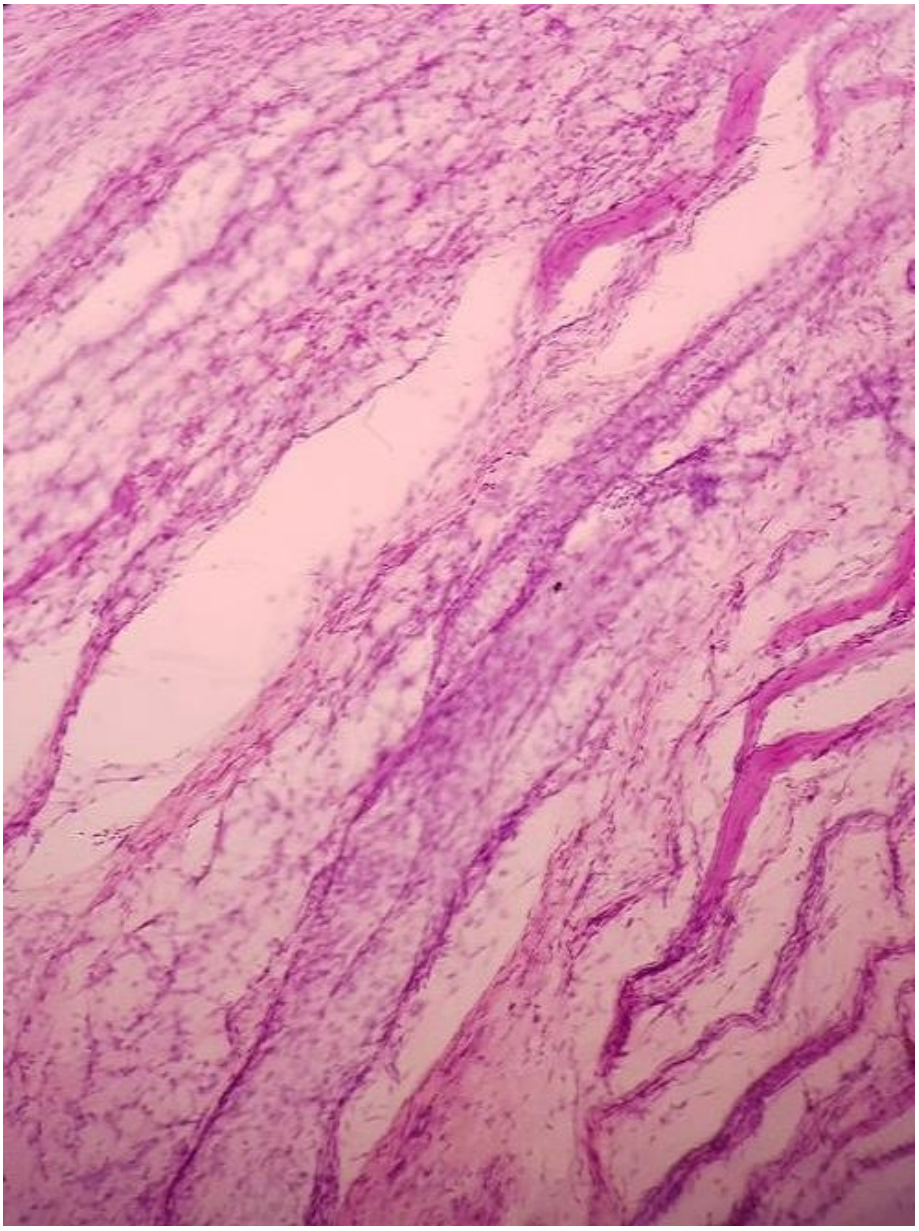
RIGHT SHOULDER



Macroscopic tear in articular surface



Macroscopic tear in articular surface



Articular slide showing disoriented collagen fibres with focal thinning and collagen split, H&E stain, original magnification x10

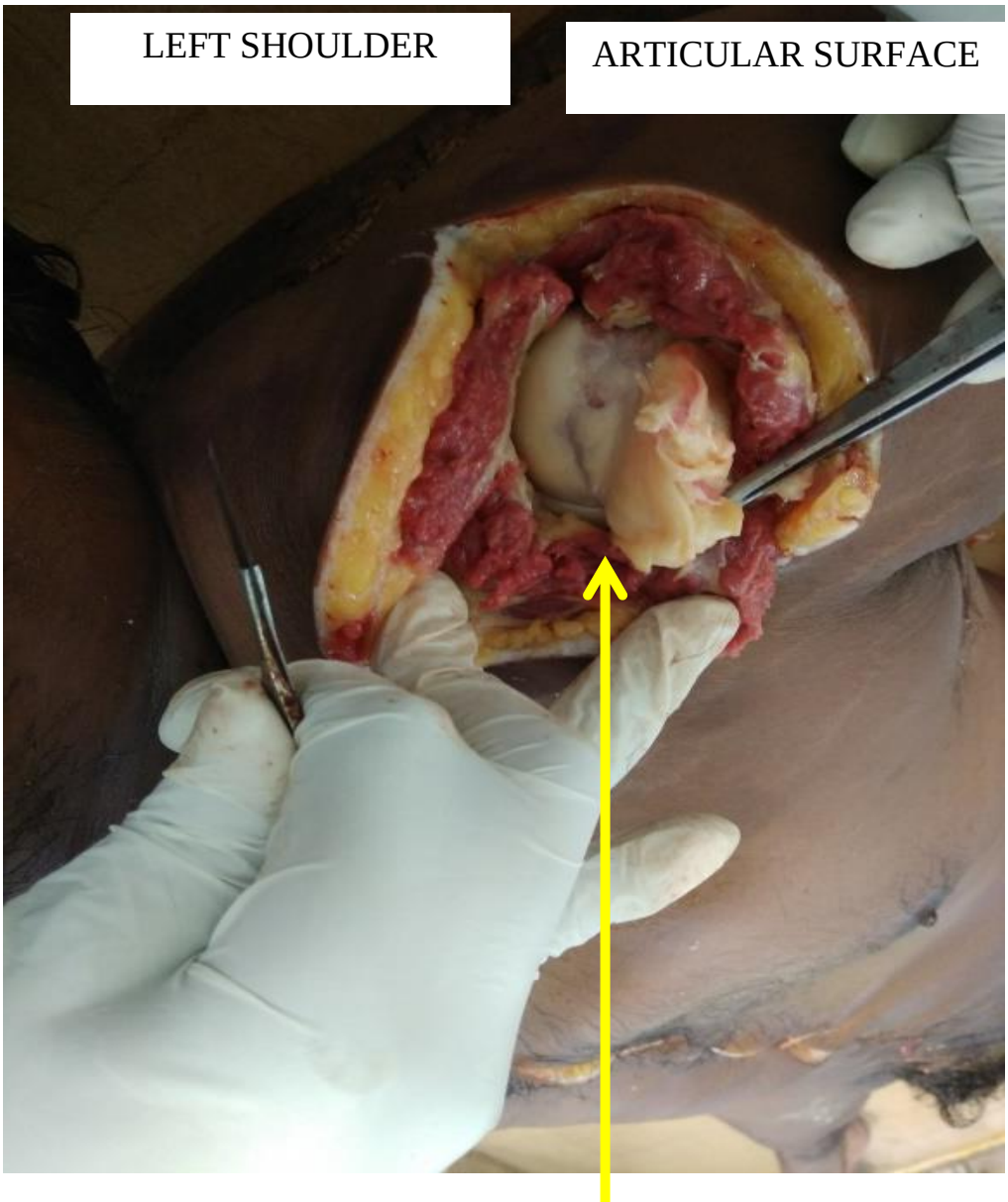
SUBJECT 8

S.NO – 35

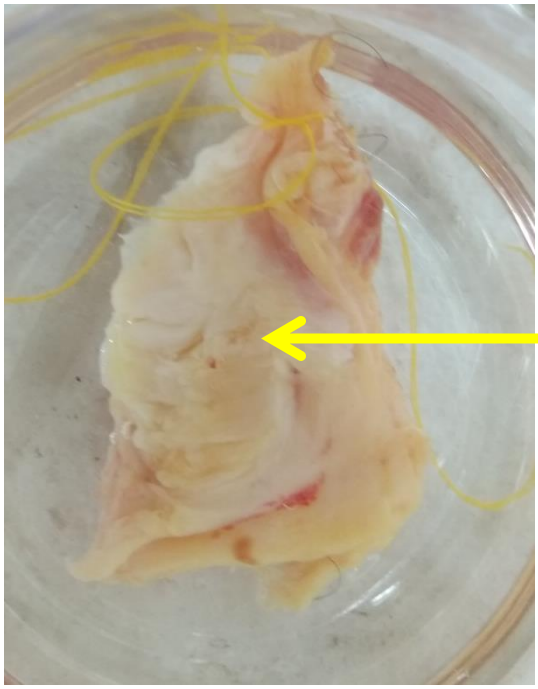
Age at death/sex: 42/M Occupation : MANUAL LABOURER

Specimen : LEFT Macroscopic : LEFT ARTICULAR TEAR

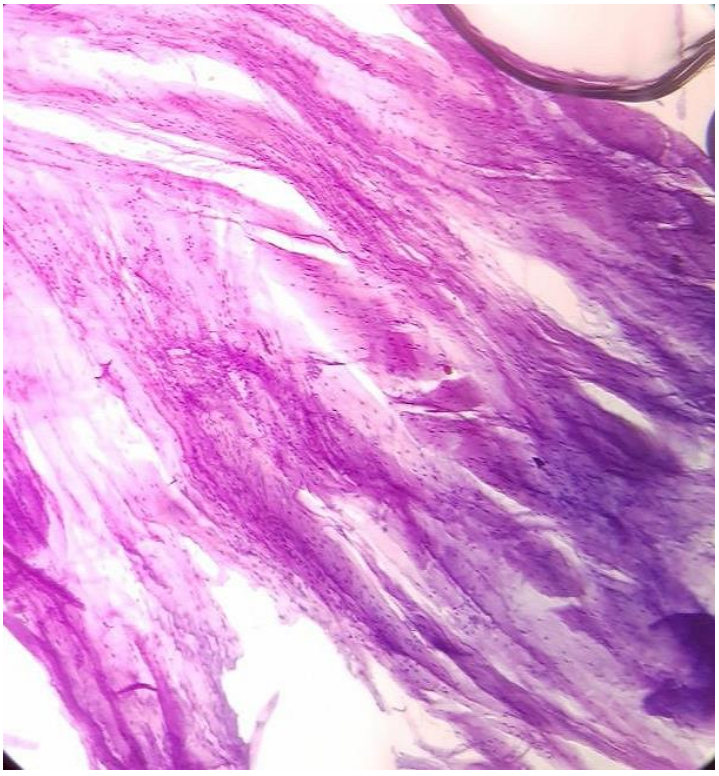
Hooked acromion : ABSENT Microscopic: ARTICULAR TEAR



Macroscopic tear in articular surface



Macroscopic tear in articular surface



Articular slide showing disoriented collagen fibres with focal thinning and collagen split, H&E stain, original magnification x10

SUBJECT 9

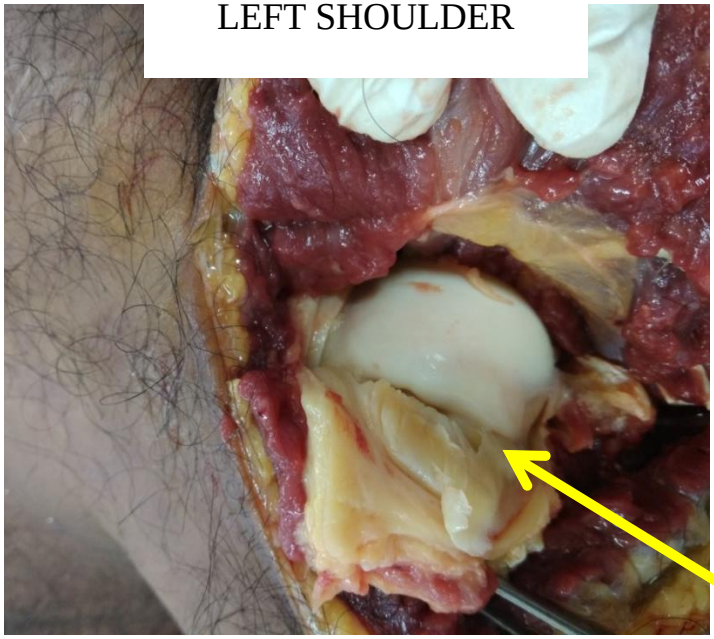
S.NO - 33

Age at death/sex: 49/M Occupation : MANUAL LABOURER

Specimen : BILATERAL Macroscopic : B/L ARTICULAR TEAR

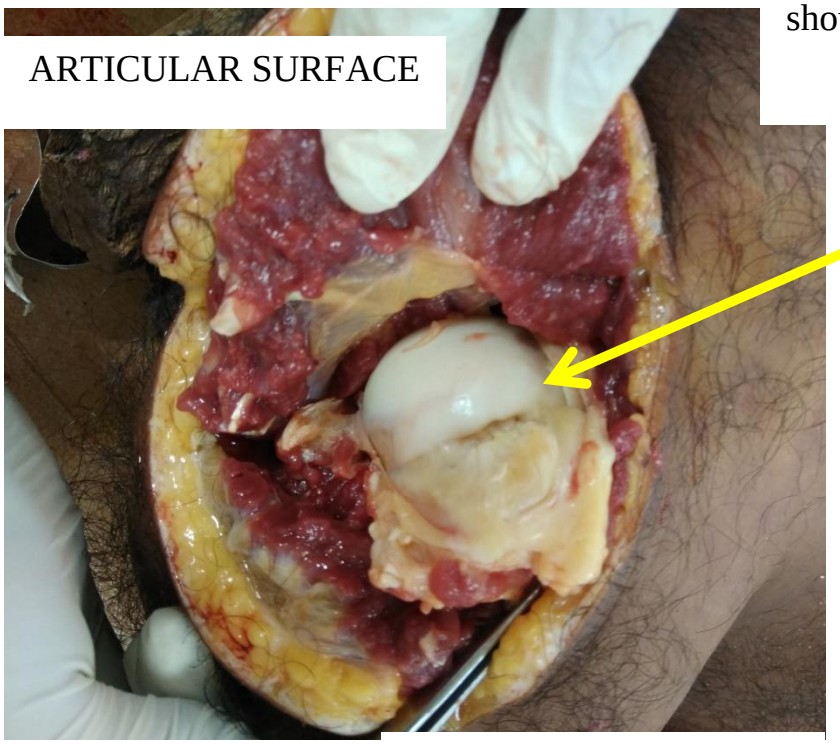
Hooked acromion : ABSENT Microscopic: B/L ARTICULAR TEAR

LEFT SHOULDER



Left and right shoulder showing macroscopic tear in articular surface

ARTICULAR SURFACE



RIGHT SHOULDER

SUBJECT 10

S.NO - 25

Age at death/sex: 50/M Occupation : MANUAL LABOURER

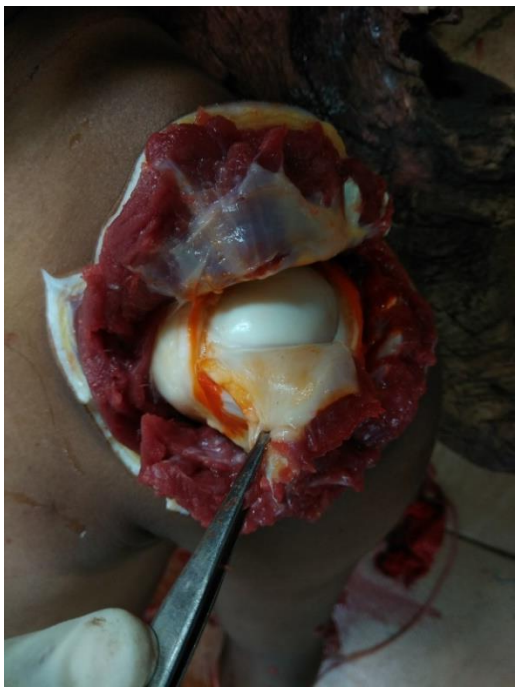
Specimen : BILATERAL Macroscopic : NO TEAR

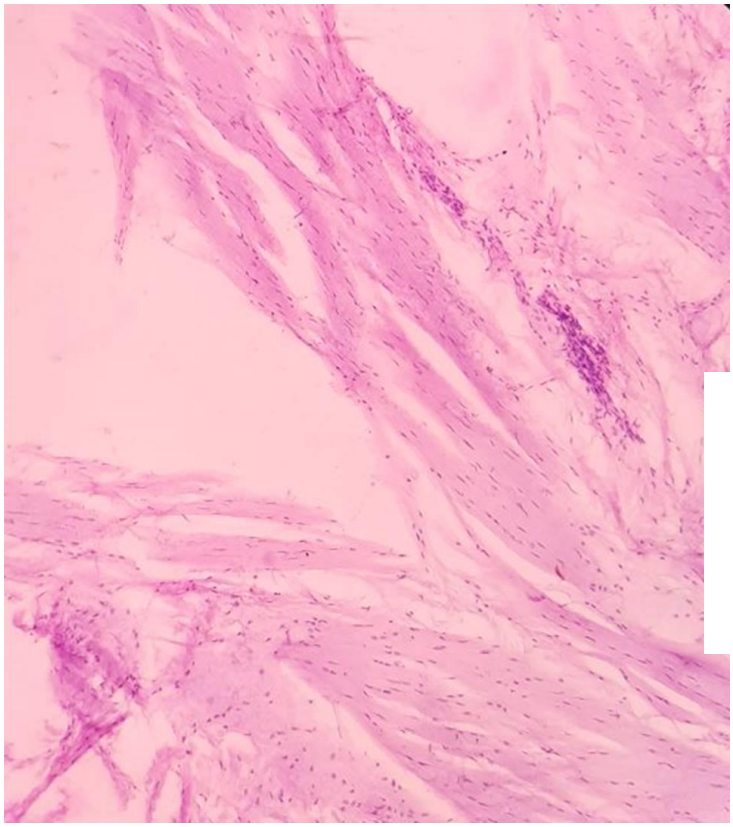
Hooked acromion : ABSENT Microscopic: B/L BURSAL TEAR

ARTICULAR SURFACE

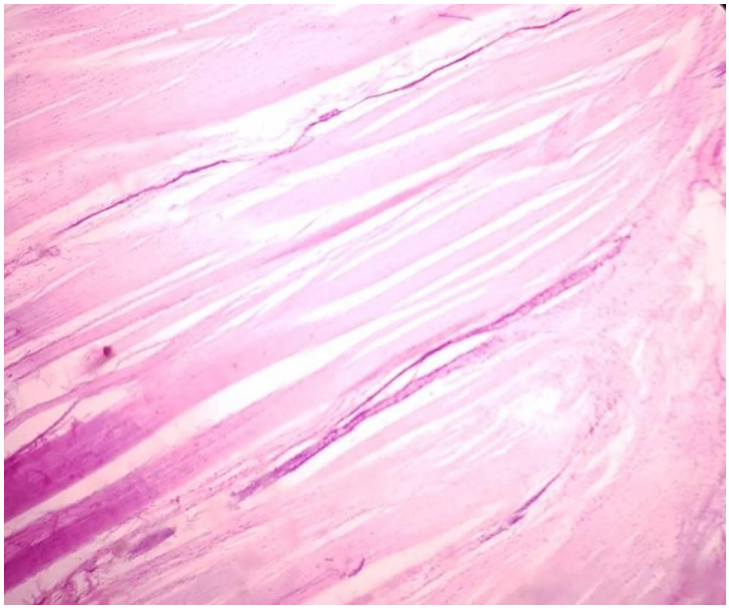
RIGHT SHOULDER

LEFT SHOULDER





Bursal slide showing disoriented collagen fibres with focal thinning and collagen split, H&E stain, original magnification x10.



Bursal slide showing collagen fibres split. H&E stain. Original magnification x 4x.

SUBJECT 11

S.NO- 29

Age at death/sex: 50/M

Occupation : BUSINESSMAN

Specimen : LEFT SIDE

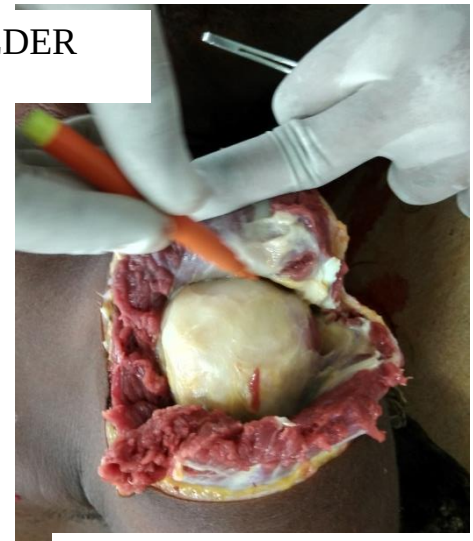
Macroscopic : NO TEAR

Hooked acromion : ABSENT

Microscopic: INTERSTITIAL TEAR

LEFT SHOULDER

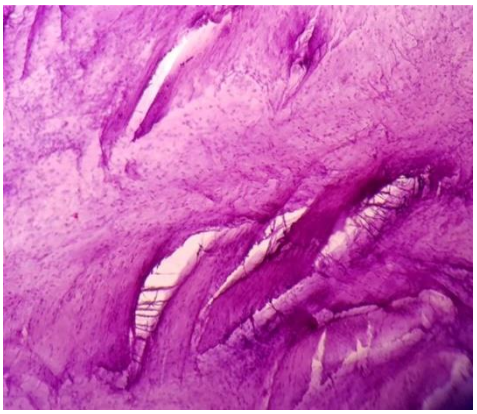
ARTICULAR SURFACE



BURSAL SURFACE

BURSAL

ARTICULAR



Degenerated tendon cuff showing features of calcification and mild to moderate fibroblast proliferation . H&E stain. Original magnification x

DISCUSSION

The prevalence of rotator cuff tears has been widely assessed. Estimates vary, but can be as high as 80%of 80-year-olds. In the past literature, the cadaveric population tends to be older than those in the radiological studies and so the prevalence of tears was found to be higher than actual prevalence. So in our study we included only the younger population from 20-50 years. We categorise our study population to aid in acknowledging the aetiology of rotator cuff tear as the lower extreme of our study population is vulnerable for traumatic injuries like sports injury and the higher extreme may have ongoing ageing changes like degeneration.

This study reviewed the prevalence of rotator cuff tears in the cadaveric populations irrespective of symptoms. As no clinical data on shoulder complaints are available for the cadaveric population, it is reasonable to assume that, as in any large sample, some had symptomatic shoulders. The prevalence of rotator cuff tear in asymptomatic subjects as determined by magnetic resonance imaging (MRI) and ultrasonography should be lower than the prevalence in cadaveric population. Conversely, the radiological prevalence of rotator cuff tears in a population with symptomatic shoulders should be higher than the prevalence in cadaveric population.

The prevalence of RCT in cadaveric population as per our study was found to be 14.8% which was lower than that in literature(30.24%) as most of them included older population. All those tears in our cadaveric population were found to be partial thickness tears (14.8%), making it more prevalent than FTT, which correspond with literature (PTT-18.49% > FTT-11.75%). As none of our cadaveric population has FTT, we are of the opinion that the size of the PTT progresses with age to evolve into FTT.

Our study results correspond to the opinion expressed in the literature that prevalence of the rotator cuff tear increases with the age. In the population we studied, the rotator cuff tear prevalence was 7.69% in 20-30 years population, 14.28% in 31-40 years population and 28.57% in 41-50 years population. This difference is significant enough to show that prevalence of RCT increases with age.

We found that the prevalence of PTT in males (15.55%) is higher than that in females (11.11%). But this difference is insignificant as the p-value is more than 0.05.

Among 46 subjects dissected bilaterally, rotator cuff tear was found in 6 subjects and all those 6 subjects had tear bilaterally (100%) and none of them had unilateral tear. This correlates with the study by Liem and Buschmann (48) suggesting the contralateral involvement in patients previously operated for full/partial thickness tear.

PTT occur with nearly equal frequency on either side in our study (right-12%, left-16%). This difference is insignificant and is because, in 2 subjects with left sided PTT, right shoulders were excluded from the study. This did not support the opinion in the literature that RCT of the dominant extremity are more common. Nearly half of the RCT we observed were in the left shoulder, while it is highly unlikely that half of our study population are left handed.

Our study indicate that bursal sided PTT (7.40%) are more common than the articular sided PTT (5.56%) and interstitial tears (1.85%), which is in contrary to the literature that the interstitial tears are more common than articular sided and bursal sided tears as studied by Yamanaka et al. [5] with a prevalence of, 3% on bursal side, 3% on articular side, and 7% were intratendinous . This may be because the interstitial tears are more commonly due to degeneration that occurs with age and our study population includes younger age group than that in the literature.

We observed that the prevalence of articular sided tears increases with age. The prevalence was 14.28% in 41-50 years population and 7.14% in 31-40 years population, and was higher in male population. The difference in involvement of right and left shoulders is insignificant. The prevalence of bursal sided tears is nearly equal in all the age groups of our study and involvement of either side is equal. The prevalence among

female subjects (11.11%) is more than that in male subjects (6.66%) and this corresponds with the opinion expressed in the literature.

The prevalence of hooked acromion in our study population is 1.85% and was associated with bursal sided PTT indicating that extrinsic impingement is a causal factor for RCT. Interstitial tears were observed with the prevalence of 7.14% in the age group 41-50 years and not in other age groups of our study. This shows that the interstitial tears are more commonly due to ageing process like degeneration.

CONCLUSION

- Overall prevalence of rotator cuff tear in the cadaveric population aged between 20 and 50 years in this study is 14.8%.
- The prevalence of rotator cuff tear increases with the age suggesting age related degeneration in the pathogenesis of rotator cuff tear.
- The prevalence of hooked acromion is 1.85% in our study, with a strong association in development of bursal tear by external impingement.
- As there is strong evidence of bilateral presence of rotator cuff tear it is important to screen the asymptomatic contralateral shoulder in patients with rotator cuff tear.
- In contrary , there is no correlation between the handedness of individual and the development of rotator cuff tear as both sides have equal prevalence in our study and also the overhead activities doesn't imply any significant influence in the development of rotator cuff tear .
- No significant difference in prevalence of rotator cuff tear in both genders.

BIBLIOGRAPHY

1. Smith JG (1834) Pathological appearances of seven cases of injury of the shoulder joint with remarks. London Med Gazette 14:280
2. Keyes EL (1933) Observations on rupture of supraspinatus tendon. Based upon a study of 73 cadavers. Ann Surg 97:849–856
3. Cotton RE, Rideout D (1964) Tears of the humeral rotator cuff: a radiological and pathological necropsy survey. J Bone Joint Surg Br 46:314–328
4. Neer CS II (1983) Impingement lesions. Clin Orthop Relat Res 173:70–77
5. Yamanaka K, Fukuda H, Hamada K et al (1983) Incomplete thickness tears of the rotator cuff. OrthopTraumatol Surg (Tokyo) 26:713
6. Fukuda H, Mikasa M, Yamanaka K (1987) Incomplete thickness rotator cuff tears diagnosed by subacromial bursography. Clin Orthop Relat Res 223:51–58
7. Fukuda H (1980) Rotator cuff tears. Geka Chiryo (Osaka) 43:28
8. Fukuda H, Mikasa M, Ogawa K et al (1983) The partial thickness tear of rotator cuff. Orthop Trans 7:137
9. Lehman C, Cuomo F, Kummer FJ et al (1995) The incidence of full thickness rotator cuff tears in a large cadaveric population. Bull Hosp Jt Dis 54:30–31

10. De Palma AF (1983) Surgery of the shoulder, 3rd edn. JB Lippincott, New York, pp 211–221
11. Uhthoff HK, Loehr J, Sarkar K (1986) The pathogenesis of rotator cuff tears. Proceedings of the third international conference on surgery of the shoulder, Fukuora, 27 Oct 1986. pp 211–212
12. Ozaki J, Fujimoto S, Nakagawa Y, Masuhara K, Tamai S (1988) Tears of the rotator cuff of the shoulder associated with pathological changes in the acromion. A study in cadavers. J Bone Joint Surg Am 70:1224–1230
13. Pieper H-G, Radas C (1998) The prevalence of rotator cuff tear. Proceedings of the International Congress on Surgery of the Shoulder, Sydney, Australia, p. 64.
14. Codman EA (1934) The shoulder. Thomas Todd, Boston
15. Skinner H (1937) Anatomical considerations relative to rupture of the supraspinatus tendon. J Bone Joint Surg 19:137–151
16. Lindblom K, Palmer I (1939) Ruptures of the tendon aponeurosis of the shoulder joint. Acta Chir Scand 82:133–142
17. Wilson C, Duff G (1943) Pathological study of degeneration and rupture of the supraspinatus tendon. Arch Surg 47:121–135
18. Grant J, Smith C (1948) Age prevalence of rupture of the supraspinatus tendon. Proc Am Assoc Anat 666

19. Refi or H, Melzer C (1984) Makroskopische und mikroskopische Autopsiebefundeander Rotatorenmanschette. Z Unfallchir Vers med Berufskr 77:139–142

20. Petersson C (1984) Ruptures of the supraspinatus tendon. Acta Orthop Scand 55:52–56

21. Bigliani LU, Morrison D, April E (1986) The morphology of the acromion and its relationship to rotator cuff disease. Orthop Trans 10:228

22. Salter E, Nasca R, Shelly B (1987) Anatomical observations on the acromioclavicular joint and supporting ligament. Am J Sports Med 115:119–207

23. Ogata S, Uhthoff HK (1990) Acromial enthesopathy and rotator cuff tear. A radiologic and histologic postmortem investigation of the coracoacromial arch. Clin Orthop 254:39–48

24. Jerosch J, Muller T, Castro WH (1991) The prevalence of rotator cuff rupture: an anatomic study. Acta Orthop Belg 57:124–129

25. Kolts I (1992) A note on the anatomy of the supraspinatus muscle. Arch Orthop Trauma Surg 111:247–249

26. Hijioka A, Suzuki K, Nakamura T, Hojo T (1993) Degenerative change and rotator cuff tears. An anatomical study in 160 shoulders of 80 cadavers. Arch Orthop Trauma Surg 112:61–64

27. Panni AS, Milano G, Lucania L, Fabbriciani C, Logroscino CA (1996) Histological analysis of the coracoacromial arch: correlation between age related changes and rotator cuff tears. Arthroscopy 12:531–540

28. Sakurai G, Ozaki J, Tomita Y, Kondo T, Tamai S (1998) Incomplete tears of the subscapularis tendon associated with tears of the supraspinatus tendon: cadaveric and clinical studies. J Shoulder Elbow Surg 7:510–515

29. Sano H, Ishii H, Trudel G, Uhthoff HK (1999) Histologic evidence of degeneration at the insertion of 3 rotator cuff tendons: a comparative study with human cadaveric shoulders. J Shoulder Elbow Surg 8:574–579

30. Jiang Y, Zhao J, Van Holsbeeck MT, Flynn MJ, Ouyang X, Genant HK (2002) Trabecular microstructure and surface changes in the greater tuberosity in rotator cuff tears. Skeletal Radiol 31:522–528

31. Hashimoto T, Nobuhara K, Hamada T. Pathologic evidence of degeneration as a primary cause of rotator cuff tear. Clin Orthop Relat Res 2003 ;415:111-120.

32. Tempelhof S, Rupp S, Seil R (1999) Age-related prevalence of rotator cuff tears in asymptomatic shoulders. J Shoulder Elbow Surg 8:296–299

33. Reilly P, Macleod I, Macfarlane R, Windley J, Emery R. Dead men and radiologists don’t lie: a review of cadaveric and radiological studies of rotator cuff tear prevalence. Ann R Coll Surg Engl 2006; 88:116-121

34.de Mos M, van der Windt AE, Jahr H, et al. Can platelet-rich plasma enhance tendon repair? A cell culture study. Am J Sports Med. 2008;36(6):1171-8.

35.Rutolo C, Foe JE, Nottage WM . The Supraspinatus foot print; an anatomic study of the supraspinatus insertion.Arthroscopy2004;20:246-249

36.McConville OR,Iannotti JP. Partial thickness tear of the rotator cuff : evaluation and management. J Am Acad Orthopaedic Surg.1999;7;32-43 97 37. Bassett RW, Browne AO, Morrey BF, An KN: Glenohumeral muscle force and moment mechan- ics in a position of shoulder instability. J Biomech 1990;23:405–415.

38. Karduna AR, Williams GR, Williams JL, Iannotti JP: Kinematics of the glenohumeral joint: influences of muscle forces, ligamentous constraints, and articu- lar geometry. J Orthop Res 1996;14:986–993.

39. Lippitt S, Matsen F: Mechanisms of glenohumeral joint stability. Clin Orthop Relat Res 1993:20–28.

40.Soslowsky LJ, Carpenter JE, Bucchieri JS, Flatow EL: Biomechanics of the rotator cuff. Orthop Clin North Am 1997;28:17–30.

41. Wuelker N, Roetman B, Plitz W, Knop C: Function of the supraspinatus muscle in a dynamic shoulder model (in German). Unfallchirurg 1994;97:308–313.

42. Sharkey NA, Marder RA, Hanson PB: The entire rotator cuff contributes to elevation of the arm. J Orthop Res 1994;12:699–708. 98 press).

43.Localised deposition of amyloid in tears of the rotator cuff ;Cole AS[1], Cordiner-Lawrie S, Carr AJ, Athanasou NA,J Bone Joint Surg Br. 2001 May;83(4):561-4.

44.Abate M, Schiavone C, Di Carlo L, Salini V. Prevalence of and risk factors for asymptomatic rotator cuff tears in postmenopausal women. Menopause 2014; 21: 275-280 [PMID: 23760436 DOI: 10.1097/GME.0b013e31829638e3]

45 Pauly S, Stahnke K, Klatte-Schulz F, Wildemann B, Scheibel M, Greiner S. Do patient age and sex influence tendon cell biology and clinical/radiographic outcomes after rotator cuff repair? Am J Sports Med 2015; 43: 549-556 [PMID: 25573392 DOI: 10.1177/03635465 14562552]

46 Milgrom C, Schaffler M, Gilbert S, van Holsbeeck M. Rotator-cuff changes in asymptomatic adults. The effect of age, hand

dominance and gender. J Bone Joint Surg Br 1995; 77: 296-298 [PMID: 7706351]

47 Brasseur JL, Lucidarme O, Tardieu M, Tordeur M, Montalvan B, Parier J, Le Goux P, Gires A, Grenier P. Ultrasonographic rotatorcuff changes in veteran tennis players: the effect of hand dominance and comparison with clinical findings. Eur Radiol 2004; 14: 857-864 [PMID: 14610684]

48 Liem D, Buschmann VE, Schmidt C, Gosheger G, Vogler T, Schulte TL, Balke M. The prevalence of rotator cuff tears: is the contralateral shoulder at risk? Am J Sports Med 2014; 42: 826-830 [PMID: 24500916 DOI: 10.1177/0363546513519324]

49 Ro KH, Park JH, Lee SH, Song DI, Jeong HJ, Jeong WK. Status of the contralateral rotator cuff in patients undergoing rotator cuff repair. Am J Sports Med 2015; 43: 1091-1098 [PMID: 25740834]

50 Baumgarten KM, Gerlach D, Galatz LM, Teefey SA, Middleton WD, Ditsios K, Yamaguchi K. Cigarette smoking increases the risk for rotator cuff tears. Clin Orthop Relat Res 2010; 468: 1534-1541 [PMID: 19283436 DOI: 10.1007/s11999-009-0781-2]

51 Bishop JY, Santiago-Torres JE, Rimmke N, Flanigan DC. Smoking Predisposes to Rotator Cuff Pathology and Shoulder Dysfunction: A Systematic Review. Arthroscopy 2015; 31: 1598-1605 [PMID: 25801046 DOI: 10.1016/j.arthro.2015.01.026]

52 Carbone S, Gumina S, Arceri V, Campagna V, Fagnani C, Postacchini F. The impact of preoperative smoking habit on rotator cuff tear: cigarette smoking influences rotator cuff tear sizes. J Shoulder Elbow Surg 2012; 21: 56-60 [PMID: 21524922 DOI: 10.1016/j.jse.2011.01.039]

53 Tashjian RZ, Farnham JM, Albright FS, Teerlink CC, Cannon-Albright LA. Evidence for an inherited predisposition contributing to the risk for rotator cuff disease. J Bone Joint Surg Am 2009; 91: 1136-1142 [PMID: 19411462 DOI: 10.2106/JBJS.H.00831]

54 Yamamoto A, Takagishi K, Kobayashi T, Shitara H, Ichinose T, Takasawa E, Shimoyama D, Osawa T. The impact of faulty posture on rotator cuff tears with and without symptoms. J Shoulder Elbow Surg 2015; 24: 446-452 [PMID: 25441565 DOI: 10.1016/j.jse.2014.07.012]

55 Gumina S, Di Giorgio G, Postacchini F, Postacchini R. Subacromial space in adult patients with thoracic hyperkyphosis and in healthy volunteers. Chir Organi Mov 2008; 91: 93-96 [PMID: 18320381 DOI: 10.1007/s12306-007-0016-1]

56. Minagawa H, Itoi E (2006) Clinical relevance of the rotator cuff in shoulder with pain and dysfunction. Kansetsugeka 25:923–929

57. Crass J, Craig E, Feinburg S (1988) Ultrasonography of rotator cuff tears: a review of 500 diagnostic studies. J Clin Ultrasound 16:313–327

58. Chandnani V, Ho CP, Neumann C, Gerharter J, Kursunoglu-Brahme S, Sartoris D (1991) MR fi ndings in asymptomatic shoulders. Clin Imaging 16:25–30

59. Schibany N, Zehetgruber H, Kainberger F, Wurnig C, Ba-ssalamah A, Herneth AM (2004) Rotator cuff tears in asymptomatic individuals: clinical and ultrasonographicscreening study. Eur J Radiol 51:263–268

60. Pettersson G (1942) Rupture of the tendon aponeurosis of the shoulder joint in antero-inferior dislocation. Acta Chir Scand Suppl 77:1–187

61. Lenza M, Buchbinder R et al (2013) Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered. Cochrane Database Syst Rev (9):CD009020

62. Roy JS, Braën C, Leblond J, Desmeules F, Dionne CE, MacDermid JC, Bureau NJ, Frémont P. Diagnostic accuracy of ultrasonography, MRI and MR arthrography in the characterisation of rotator cuff disorders: a systematic review and meta-analysis. Br

J Sports Med 2015; 49: 1316-1328 [PMID: 25677796 DOI: 10.1136/ bjsports-2014-094148]

63. Rutten MJ, Spaargaren GJ, van Loon T, de Waal Malefijt MC, Kiemeney LA, Jager GJ. Detection of rotator cuff tears: the value of MRI following ultrasound. Eur Radiol 2010; 20: 450-457 [PMID:19727754 DOI: 10.1007/s00330-009-1561-9]
64. Yamaguchi K, Ditsios K, Middleton WD, Hildebolt CF, Galatz LM, Teefey SA. The demographic and morphological features of rotator cuff disease. A comparison of asymptomatic and symptomatic shoulders. J Bone Joint Surg Am 2006; 88: 1699-1704[PMID: 16882890]
65. Burkhart SS, Esch JC, Jolson RS. The rotator crescent and rotator cable: an anatomic description of the shoulder's "suspension bridge." Arthroscopy. 1993;9(6):611-616.
66. Clark JM, Harryman DT 2nd. Tendons, ligaments, and capsule of the rotator cuff. Gross and microscopic anatomy. J Bone Joint Surg Am. 1992;74(5): 713-725.

STUDY PROFOMA

"CADAVERIC ANALYSIS OF ROTATOR CUFF TEAR PREVALENCE IN PHYSICALLY ACTIVE AGE GROUP(20-50 YEARS)"

NAME: DATE OT SAMPLE COLLECTION:

AGE/SEX: OCCUPATION:

TEAR :

	RT SIDE	LT SIDE
MICROSCOPIC		
MACROSCOPIC		

	RT SIDE	LT SIDE
FULL THICKNESS		
PARTIAL THICKNESS		

FULL THICKNESS : **DeOrio and Cofield Classification**

SMALL(<1)	
MEDIUM(1-3cm)	
LARGE(3-5cm)	
MASSIVe(>5)	

PARTIAL THICKNESS : SIDE

BURSAL	
ARTICULAR	
INTRATENDINOUS	

HOOKED ACROMION	RT SIDE	LT SIDE

PATHOLOGY REPORT:

MASTER CHART

S.NO	NAME	AGE	SEX	OCCUPATION	SIDE DISSECTED	ROTATOR CUFF TEAR	MACROSCOPIC TEAR	MICROSCOPIC TEAR	PARTIAL THICKNESS TEAR	FULL THICKNESS TEAR	HOOKED ACROMION
1	PALANI	23	MALE	FISHERMAN	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
2	RAJAPANDI	46	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
3	MUTHULAKSHMI	48	FEMALE	RETAILER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
4	KANNAN	50	MALE	FARMER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
5	DHILEEPAN	21	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
6	JEYAKUMAR	48	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
7	DINESH KUMAR	24	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
8	SURESH	31	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
9	GUNASEKARAN	29	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
10	MUTHUMANI	28	FEMALE	HOME MAKER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
11	VIJAYAKUMAR	25	MALE	METAL WORKER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
12	MARUTHAMMAL	30	FEMALE	FARMER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
13	KARTHICKRAJA	20	MALE	CARPENTOR	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
14	CHINNAYA	34	MALE	MANUAL LABOURER	LEFT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
15	MARTIN	38	MALE	MECHANIC	RIGHT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT

S.NO	NAME	AGE	SEX	OCCUPATION	SIDE DISSECTED	ROTATOR CUFF TEAR	MACROSCOPIC TEAR	MICROSCOPIC TEAR	PARTIAL THICKNESS TEAR	FULL THICKNESS TEAR	HOOKED ACROMION
16	KANNAN	28	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
17	MANI	45	MALE	RETAILER	RIGHT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
18	RAMAN	45	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
19	THANGASAMY	26	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
20	MARISAMY	40	MALE	RETAILER	BILATERAL	PRESENT B/L	ABSENT	PRESENT B/L	BURSAL TEAR	ABSENT	PRESENT-B/L
21	ALAMELUMANGAI	30	FEMALE	HOME MAKER	RIGHT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
22	ARUNKUMAR	25	MALE	MANUAL LABOURER	BILATERAL	PRESENT B/L	ABSENT	PRESENT B/L	BURSAL TEAR	ABSENT	ABSENT
23	VIVEK	27	MALE	BUSINESSMAN	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
24	ARANGANATHAN	34	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
25	MUTHUPANDI	50	MALE	MANUAL LABOURER	BILATERAL	PRESENT B/L	ABSENT	PRESENT B/L	BURSAL TEAR	ABSENT	ABSENT
26	MARIMUTHU	35	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
27	ARUNPANDIAN	29	MALE	METAL WORKER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
28	BALAMURUGAN	26	MALE	FARMER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
29	PANDIYAN	50	MALE	BUSINESSMAN	LEFT	PRESENT - LEFT	ABSENT	PRESENT LEFT	INTERSTITIAL TEAR	ABSENT	ABSENT
30	KUMAR	36	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT

S.NO	NAME	AGE	SEX	OCCUPATION	SIDE DISSECTED	ROTATOR CUFF TEAR	MACROSCOPIC TEAR	MICROSCOPIC TEAR	PARTIAL THICKNESS TEAR	FULL THICKNESS TEAR	HOOKED ACROMION
31	PANDIARASI	24	FEMALE	HOME MAKER	BILATERAL	PRESENT B/L	ABSENT	PRESENT B/L	BURSAL TEAR	ABSENT	ABSENT
32	RAVI	48	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
33	AYYANAR	49	MALE	MANUAL LABOURER	BILATERAL	PRESENT B/L	PRESENT B/L	PRESENT B/L	ARTICULAR TEAR	ABSENT	ABSENT
34	MURUGAN	37	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
35	ANNADURAI	42	MALE	MANUAL LABOURER	LEFT	PRESENT -LEFT	PRESENT - LEFT	PRESENT - LEFT	ARTICULAR TEAR	ABSENT	ABSENT
36	KEERTHANA	20	FEMALE	HOME MAKER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
37	GOWTHAMAN	29	MALE	CONSTRUCTION WORKER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
38	KAVIPRIYA	20	FEMALE	STUDENT	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
39	ARUNKUMAR	25	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
40	CHINNAKANNAN	30	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
41	SANKAR	29	MALE	MANUAL LABOURER	RIGHT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
42	KUMARESAN	40	MALE	MANUAL LABOURER	BILATERAL	PRESENT B/L	PRESENT B/L	PRESENT B/L	ARTICULAR TEAR	ABSENT	ABSENT
43	ANANDH	23	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
44	RAJA	32	MALE	PAINTER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
45	SELVAKUMAR	26	MALE	EMPLOYER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT

S.NO	NAME	AGE	SEX	OCCUPATION	SIDE DISSECTED	ROTATOR CUFF TEAR	MACROSCOPIC TEAR	MICROSCOPIC TEAR	PARTIAL THICKNESS TEAR	FULL THICKNESS TEAR	HOOKED ACROMION
46	MURUGAN	42	MALE	FARMER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
47	VEERALAKSHMI	40	FEMALE	HOME MAKER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
48	RAJA	43	MALE	FARMER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
49	SANTHOSH	45	MALE	EMPLOYER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
50	SURESH KUMAR	31	MALE	MECHANIC	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
51	RAGUPATHI	24	MALE	MECHANIC	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
52	VALLI	37	FEMALE	HOME MAKER	LEFT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
53	MARUDHUPANDIYAN	27	MALE	PROFESSIONAL	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
54	KARUPAIYA	36	MALE	MANUAL LABOURER	BILATERAL	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT

APPROVAL FROM FORENSIC MEDICINE DEPARTMENT

1003244

12 APR 2017

From

Dr G Shankara Shanmuga Sethu,
M S Orthopaedics Post Graduate,
Govn Rajaji Hospital & Madurai Medical College,
Madurai.

To

The Head Of Department,
Department of Forensic Medicine,
Govn Rajaji Hospital &Madurai Medical College,
Madurai.

Through Dean

Respected Sir,

SUB : Permission to undergo cadaveric study

Sir, I Dr G Shankara Shanmuga Sethu, second year M S Orthopaedics Post Graduate have obtained Ethical Committee approval for my Dissertation study " Cadaveric analysis of rotator cuff tear prevalence in physically active age group (20-50 years)". So kindly permit me to undergo cadaveric study.

Thanking you,

Yours truthfully,

G Shankara Shanmuga Sethu

Date : 12 .4.17
Place :Madurai

APPROVAL FROM PATHOLOGY DEPARTMENT

From

Dr.G .Shankara Shanmuga sethu ,
M.S Orthopaedics Post Graduate,
Govt. Rajaji hospital & Madurai Medical College,
Madurai.

TO

The Professor and Head Of Department,
Department of Pathology,
Govt. Rajaji hospital & Madurai Medical College,
Madurai.

THROUGH PROPER CHANNEL,

Respected Madam,

Sub: Regarding permission to dissertation study on " A CADAVERIC STUDY ON THE PREVALENCE OF ROTATOR CUFF TEAR IN GENERAL POPULATION "

I joined my M.S Orthopaedics Post graduation course in Department of Orthopaedics and Traumatology in May 2015.In the present era we are getting more number of shoulder cases in Orthopaedic OPD(Sports clinic) and in order to evaluate the prevalence of rotator cuff injuries, I am planning to do a study under the title of " A CADAVERIC STUDY ON THE PREVALENCE OF ROTATOR CUFF TEAR IN GENERAL POPULATION " in the Forensic Medicine ,Govt. Rajaji hospital & Madurai Medical College,Madurai. I request you to grant me permission to do the study and use the facilities available in your Department.

Thanking you ,

Yours faithfully,

(G. SHANKARA SHANMUGA SETHU)

Place: Madurai

Date: 12/7/2016

12/07/16

PROFESSOR AND HOD OF PATHOLOGY
MADURAI MEDICAL COLLEGE
MADURAI-625020

ETHICAL COMMITTEE APPROVAL

MADURAI MEDICAL COLLEGE
MADURAI, TAMILNADU, INDIA -625 020
(Affiliated to The Tamilnadu Dr.MGR Medical University, Chennai, Tamil Nadu)

ETHICS COMMITTEE CERTIFICATE

Name of the Candidate	:	Dr.G.Shankara shanmuga sethu,
Course	:	PG in MS., Orthopaedics
Period of Study	:	2015-2018
College	:	MADURAI MEDICAL COLLEGE
Research Topic	:	Cadaveric analysis of rotator cuff tear prevalence in physically active age group (20-50 years)
Ethical Committee as on	:	17.03.2017

The Ethics Committee, Madurai Medical College has decided to inform that your Research proposal is accepted.

Member Secretary

Chairman

Prof.Dr.V.Nagaraajan
M.D., MNAMS, D.M., Dsc.,(Neuro), Dsc (Hon)
CHAIRMAN
IEC - Madurai Medical College
Madurai

Dean / Chairman

Madurai Medical College
Madurai-20

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Instances where selected sources appear:

9

ABBREVIATIONS

RCT - ROTATOR CUFF TEAR

PTT - PARTIAL THICKNESS TEAR

FTT - FULL THICKNESS TEAR